SCIENCE LIBRARY MAR 27 1922

VOLUME 11 NUMBER 12

DECEMBER, 1921

Phytopathology

Official Organ of the American Phytopathological Society

CONTENTS

The effects of treatment for bunt on the germination of wheat ..... Orlando L. Sonnin 469

Control of stem girdle of spruce transplants caused by excessive heat ..... C. P. Lowman and N. J. Ferguson 485

Note on the hydrogen-ion concentration of potato dextrose agar and a titration curve of this medium with lactic acid ..... E. F. Hopkins 491

Some factors affecting the production of apothecia of Sclerotinia cinerea ..... Walter N. Fiscaro 495

Anthracnose of the garden pea ..... Fred Reuel Jones and R. E. Vaughan 500

Briefer articles:

Phytophthora infestans on eggplant in the United States ..... E. J. Hanzel 504

Wojnowicia graminis (Mcalp.) Sacc. and D. Sacc. on wheat in the United States ..... H. H. McKinney and A. G. Johnson 505

Incidence of loose-smut in wheat varieties ..... F. D. Fromme 507

Convenient chambers for inoculation of plants where high humidity and moderate temperatures are required ..... A. F. Camp 510

Phytopathological notes 513

PUBLISHED MONTHLY BY THE SOCIETY

OFFICE OF PUBLICATION

8 West Elm Street, Lancaster, Pa.

Entered as second-class matter at the post office at Lancaster, Pa.

Price { $3.00 per year, United States and dependencies, Mexico and Cuba
$3.25 per year, Canada
$3.50 per year, elsewhere

[illegible] Apparatus [illegible]

[illegible]

SPECIALTIES.

Best Grade of American Glassware; "Non-Sol," "Perfection" and "Pyrex;" H. H. C. Co's. Crimped White Filtering Paper, Filtering Rapidly; specially manufactured for us in America; Swedish and English Filtering Papers; Royal Berlin and Haldenwanger Berlin Porcelain Ware; Best American Porcelain Ware; Troemner and Becker Balances and Weights; Platinum Wire, Foil and Ware; Fused Silica Laboratory Utensils "Vitreosil;" Heraeus Pure Transparent Quartz Glass; Alundum Ware; Hoskins' Electric Furnaces; Le Chatelier's Pyrometers; Bausch and Lomb Microscopes and Accessories; Hydrometers and Thermometers of every description; Chemically Pure Acids and Ammonia; Merck's, Baker and Adamson's and J. T. Baker Chemical Co.'s Chemicals and Reagents; Caustic Potash and Soda, purified in sticks and pure by alcohol; Acetate of Lead, Cyanide Mixture, Soda Ash and Commercial Caustic Soda.

HENRY HEIL CHEMICAL CO.

210-214 South 4th Street St. Louis, Mo.

SMITH'S

Bacterial Diseases of Plants.

Prof. Smith first gives a synopsis of the study of bacterial diseases of plants, then the methods of research, apparatus, technic of preparation, culture media, technic of isolation, etc. He then considers in detail 14 [illegible] genera [illegible] of disease, technic of isolation, preparation and inoculation; the determination of [illegible], signs of disease, [illegible], prevention, with a complete bibliography for collateral reading.

By Erwin F. Smith, Bureau of Plant Industry, U. S. Department of Agriculture. [illegible] illustrated. Cloth, $10.00 net.

W. B. SAUNDERS COMPANY

PHILADELPHIA AND LONDON

PHYTOPATHOLOGY

VOLUME XI NUMBER 12

DECEMBER, 1921

THE EFFECTS OF TREATMENT FOR BUNT ON THE GERMINATION OF WHEAT

GEORGE L. ZUNDEL[1]

WITH TWO FIGURES IN THE TEXT

INTRODUCTION

Peculiar climatic and soil conditions are chiefly responsible for the severe smut losses in the state of Washington. In an attempt to control this smut (*Tilletia tritici*), commonly known as bunt or stinking smut, fully 99 per cent of all seed wheat planted in the state is treated by dipping in solutions of copper sulphate, copper sulphate and sodium chloride, or formaldehyde. When any seed is treated with toxic compounds, there is usually more or less injury to such seed, regardless of the care exercised. The treatment of wheat in either copper sulphate or formaldehyde is no exception to the rule. There are, however, peculiar climatic and soil factors, together with the method of threshing, which, in Washington, make seed injury a serious problem. Hot, dry weather is the usual condition at harvest time in Washington, causing the wheat kernels to be dry and brittle. When this wheat is threshed in our modern threshing machines, with high speed cylinders, many of the kernels are either broken, badly cracked, or otherwise injured. Most of the cracks are invisible to the eye, but when these kernels are dipped into fungicides they allow the fungicide to penetrate to the embryo, causing much injury.

HISTORICAL

The harmful effects of fungicides have been studied by numerous investigators in various countries. In 1876, Pierre (35) found that seeds of wheat dipped in boiling milk of lime for two or three minutes were killed; 54 per cent germinated after being dipped in a 2 per cent solution of copper sulphate for three minutes at 60° C. and 53 per cent germinated when treated at 50° C.

Kudelka (23) reported in 1876 that wheat soaked in a ½ per cent copper sulphate solution for sixteen hours was only slightly injured. However, even a two hour soak produced a slight retardation of germination.

[1] Acknowledgment is due Dr. F. D. Heald of the State College of Washington for helpful suggestions in the preparation of this manuscript and for providing means for the carrying on of this work. Helpful criticisms of manuscript were also given by Dr. Harry B. Humphrey and Dr. C. R. Ball of the U. S. Department of Agriculture.

Maercker (27) found in 1887 that sulphuric acid lowered the germination of barley from 1 to 5 per cent according to the thickness of the seed coat.

In 1890 Crozier (8) found that wheat treated with copper sulphate germinated more slowly than when untreated. He observed also that injury increased with the length of the treatment.

Jones (19) found that seed corn was injured by hot water treatment over 130° F. for fifteen minutes, as did a 6¼ per cent copper sulphate solution for twenty-four hours. The injury varied with the quality of the seed lot.

Hitchcock and Carlton (15) tested the effects of various fungicides on the germination of seed corn. The results from a large number of tests with various chemicals show that the chemicals can be classified into three groups according to the amount of injury produced.

Evans (11) of the United States Department of Agriculture, in 1896, studied the injury of wheat by fungicides and found that even small openings in the seed coat over the embryo may lead to severe injury when the seed is dipped in a fungicide.

Bolley (2) in 1897 tested the injury to germination of wheat, oats and barley after treatment with copper sulphate, sulphur dioxide, corrosive sublimate, and formaldehyde. Copper sulphate injured the germination of oats as much as 92 per cent, and wheat as much as 43 per cent. Formaldehyde injured the germination of wheat and oats up to 23 per cent. Injury was also caused by the other chemicals.

Windisch (44) treated wheat, rye, barley, and oats in formaldehyde solutions ranging from .02 to .4 per cent, soaking the cereals for twenty-four hours. The weakest solution favored the germination of oats but injured the germination of the other cereals. The strongest solution killed all of the cereal seeds.

Kinzel (21) in 1898 treated cereals with very concentrated solutions of formaldehyde but used comparatively short durations of treatment (½ to 2 hours). Concentrations of 0.1 per cent or 0.2 per cent with a duration of treatment of from one-half hour to one hour did not injure the viability or retard germination of rye and wheat, but barley and oats were injured.

In 1899, David (9) found that the degree of injury by formaldehyde varied with the different cereals, and was in direct proportion to strength of the solution and duration of treatment. The seed injury was manifest in a retarded and abnormal germination in which no roots were produced. The injurious effects of formaldehyde were reduced by soaking for fifteen minutes in a weak solution of ammonia.

Schellenburg (38) in 1899, found that when the seed coat of cereals was cracked during the process of threshing that injury to germination from treatment with formaldehyde and copper sulphate was much increased compared to cereals that had been threshed with the flail. The threshing machine usually damaged the larger kernels.

Falke (12) in 1900, showed that dipping cereals in ammonia water after the formaldehyde treatment does not stop injury to germination. His experiments showed a decrease in germination when ammonia water was used.

In 1900, Pernot (33) found that hot air treatment has a wide range of temperature without injuring oats. Injury is more liable to occur by the use of the dipping methods due to the difficulty of drying the oats.

In 1900, the Wyoming (1) Agricultural Experiment Station found that soaking wheat in copper sulphate solution of one pound to 24 gallons of water for thirteen hours, then immersing in lime water for five minutes injured the seed. Injury resulted also where a 2 per cent solution of potassium sulphide or hot water at 135° C. for fifteen minutes were used. It was supposed that the wheat grown near Laramie, Wyoming, had much thinner seed coats than usual and thus allowed the fungicides to penetrate to the embryo.

Cranefield (6, 7) in 1901, and again in 1902, found much injury to the germination of oats treated with formaldehyde. Injury increased with the length of duration of treatment and his final conclusion was that injury increased in direct proportion to the strength of the solution.

In 1901, Demoussy (10) working in France, found that copper sulphate did not penetrate the seed coats of wheat. When the treated seeds were germinated on filter paper, no injury resulted. This he attributed to the capillary action of the filter paper in drawing the copper off the seeds. No injury was noticed when the seeds were grown in soil treated with lime.

Mezentzov (28) in 1902, working in Russia, determined the effects of planting untreated and treated seed in dry and moist soil. The treatments used were copper sulphate with and without subsequent lime-water bath, and hot water. He obtained higher germination percentages in moist soil, both with untreated and treated seed.

Henderson (13) in Idaho, in 1906, found that one pound of formaldehyde to 16 gallons of water, sprinkled on oats, did not cause much injury.

Köck (22) found that seed injury from the use of formaldehyde solution varied for the different cereals. Wheat and rye were injured most, oats next, and barley the least. Increasing the strength of the formaldehyde increased the injury. The amount of injury varied with the different varieties of each cereal and with the individual lots of seed.

Sutton and Pridham (41) McAlpine (26) Sutton and Downing (42) Richardson (36) and Hurst (16) working in Australia, found less injury from formaldehyde than from copper sulphate. Liming after treating with copper sulphate lessened the injury. Hurst found that about 25 per cent of wheat was killed by the copper sulphate treatment. McAlpine found that formaldehyde-treated seed showed the lowest germination when the seed had been kept one week. At the end of two weeks the germination was much improved, while four weeks after treating it was as good as it was twenty-four hours after treatment. As a result of this investigation, he concluded that formaldehyde-treated seed should be planted before it dries.

Burmester (5) in 1908, found that copper sulphate injured the germination of wheat most, oats and barley the least.

Stevens (39) in 1909, found that the amount of injury to oats treated with formaldehyde depended upon the duration of treatment, strength of solution and quality of seed. Oats dipped in milk of lime after treatment with formaldehyde showed an improvement in percentage of germination.

In 1910, d'Ippolito (17) in Italy, found that a 5 per cent copper sulphate solution with a duration of treatment for two hours caused injury to oats but that dipping in a 5 per cent milk of lime solution prevented the injurious effects of the copper sulphate solution.

Stewart and Stevens (40) in Utah, found that the injury to wheat, oats, and barley when treated with formaldehyde increased as the concentration of the solution was increased. Wheat was injured most, barley next, and oats least.

Hiltner and Gentner (14) found that copper sulphate caused more injury than formaldehyde.

Lang,[1] in Würtemburg, presents much evidence of the increased injury to wheat treated with copper sulphate when the seed coat had previously been cracked in the process of threshing. He clearly states that his work only emphasizes a fact known for a long time.

Lesage (25) soaked wheat for periods ranging from one hour up to one hundred and ninety-five hours in solutions of copper sulphate up to 40 per cent. Solutions up to 10 per cent caused no injury but did not prevent the growth of moulds on the treated seed. Since most wheat is treated in one or two per cent solutions the author doubts that wheat is injured by treatment.

Müller, Molz, and Morgenthaler (32) noted injury to germination of treated seed. It was more prevalent in Germany during the dry season of 1911.

[1] Lang, W. Die Getreideernte von 1911 und das Beizen. Württemb. Wochenbl. f. Landw. **1912**: no. 13. Sonderabdr.

Brittlebank (4) noted that copper sulphate injured germination more than formaldehyde. He recommends that seed be planted as soon after treatment as possible.

In 1913, Johnson (18) in England, found barley resistant to both copper sulphate and formaldehyde. Wheat was injured most while oats stood strong solutions well. Injury increased as the concentration of the solutions increased. Seeds treated with copper sulphate required twice as much time to germinate.

In 1913, Picchio (34) in Italy, immersed wheat in copper sulphate solutions ranging from .5 per cent to 1.5 per cent for 5 minutes without injuring the germination, but increasing the strength of the solution to 4 per cent in .5 per cent intervals increased injury until it reached 10 per cent. Little injury resulted where wheat was soaked for one hour in a 40 per cent solution of formalin.

Riehm (37) reviews the literature on cereal-diseases in Germany for 1912. During this year Fuschini found that pre-soaking wheat reduced injury from the hot water treatment, formaldehyde and other fungicide treatments. Appel and Riehm found that there was much cracking of seed coats of cereals during the process of threshing during the excessively dry harvest of 1911. In consequence, such seed when treated for smut was severely injured. The observers state that unfortunately this fact is not generally known.

Müller and Molz (30, 31) note that wheat treated with formaldehyde and then dipped in either cold or hot water is not injured very much. They also noted that paraformaldehyde is very injurious to the germination of wheat.

Woolman (45) in 1914, working at the Washington Experiment Station, found much injury to treated wheat due to the cracking of the kernels during threshing.

In 1916, Molz (29) in Saxony, found injury to wheat when treated with formaldehyde. In an artifical seed bed the germination ranged from 14.6 per cent to 96.5 per cent and in field tests from 0 to 85.6 per cent, according to the strength of the solution.

Lakon (24) found that the hot water treatment increased the percentage of germination. If, however, the seeds were planted while wet the percentage of germination was considerably reduced.

Wallden (43) in 1917, noted most cracking of seed coats by threshing machines during dry years. Such seed when treated with formaldehyde or copper sulphate was either killed or germination was greatly retarded. By using a dilute solution of eosin the amount of cracking of the seed coat was determined. It was found that injury from the fungicides increased in proportion to the amount of cracking.

Kiessling (20) found that a 0.1 per cent solution of formaldehyde for 10–20 minutes injured the germination of oats. Fungicidal action was greater and the injury to germination less by moistening the cereals before treating with fungicides. Injury was decreased for wheat by allowing it to stand several days before planting. Paraformaldehyde caused marked injury. Seeds with cracked seed coats were injured most by formaldehyde.

Braun (3) in 1920, found that presoaking of cereals in water decreased the injurious effects of formaldehyde and copper sulphate. By presoaking cereals before treating with fungicides the cell walls of the seeds become saturated with water, thus reducing injury. The presoak method caused a stimulation of germination in a number of cases.

Since the completion of this paper two important papers on seed injury have appeared.[1]

Injury resulting from treating wheat with formaldehyde is attributed to the formation of paraformaldehyde; the injury being greatest in atmosphere with low humidity.

Badly broken seed-coats, especially over the endosperm, are subject to attack by Penicillium and Rhizopus. The vitality of seeds is a factor in determining the ability of saprophytic fungi to attack them. Threshing machine injury is responsible for a large part of the cracking of seed coats.

AMOUNT OF SEED INJURY

In order to determine the exact amount of injury, samples of wheat were collected from a number of sources in the Pacific Northwest. Most of the samples were obtained from the Office of Grain Standardization, United States Bureau of Markets, Portland, Oregon. Other samples were obtained from county agents of Washington, from the Western Washington Experiment Station at Puyallup, and from the Farm Crops Department of the State College of Washington, Pullman. After all samples of wheat were received, they were divided into groups according to variety. For each test 200 kernels were used, and after treatment the wheat was planted in flats of soil in the greenhouse. The counts for germination were made about ten days after planting.

In the first series of tests, the wheat was steeped for ten minutes in a solution of copper sulphate made at the rate of one pound of fresh copper sulphate to each 5 gallons of water (a 1–5 solution). The seed was then dried over night and planted the next day, and the flat watered at once, unless otherwise stated. In the first set of tests, the variety Red Russian was used. In order to determine how closely the results of duplicate

[1] Hurd, Annie May. Injury to seed wheat resulting from drying after disinfection with formaldehyde. Jour. Agr. Sci. **20**: 209–244. 1920.

——— Seed-coat injury and viability os seeds and barley as factors in susceptibility to molds and fungicides. Jour. Agr. Sci. **21**: 99–122. 1921

sets would check, four flats were used for each sample. Two flats were planted to treated and two to untreated seed, and the average given in table 1. In the case of the other varieties, only one flat each of treated and untreated seed was germinated. Table 1 gives the results of germination tests after treating with copper sulphate.

After testing all of the different varieties with copper sulphate, from six to twelve samples from each variety that showed the highest seed injury with copper sulphate were dipped for ten minutes in formaldehyde, one pound to 40 gallons of water, two hundred seeds being used for all samples. The results of the treatments with formaldehyde are shown in table 1.

TABLE 1

Germination of varieties of wheat in per cent following treatment with copper sulphate and formaldehyde

VARIETY	TREATMENT	NO. OF TESTS	GERMINATION PERCENTAGE			
					HAND THRESHED	
			TREATED	UNTREATED	TREATED	UNTREATED
Red Russian	$CuSO_4$	8	59.1	91.1		
" "	Formaldehyde	8	75.2	92.6		
Turkey Red	$CuSO_4$	6	37.2	82.0		
" "	Formaldehyde	5	82.7	91.0		
Pacific Blue Stem	$CuSO_4$	11	39.5	88.4		
" " "	Formaldehyde	6	65.3	96.1		
Forty Fold	$CuSO_4$	6	42.6	95.3	99.5	96.5
" "	Formaldehyde	6	65.3	100.0		
Washington Hybrid 123	$CuSO_4$	13	41.2	90.5		
" " 123	Formaldehyde	12	73.5	90.6		
" " 128	$CuSO_4$	11	40.9	91.4	93.4	96.5
" " 128	Formaldehyde	10	71.2	90.3		

RELATION OF SEED INJURY TO SEED LOT

The results in table 1 show that seed injury from treating wheat with formaldehyde or copper sulphate is general for samples obtained from various portions of the Pacific Northwest. It is also shown that the amount of seed injury is not constant for a given variety but varies with each seed lot. This variation undoubtedly is due in part to the manner in which the wheat has been threshed, since some threshing machines cause more cracking of the seed coat than others. Treatment with fungicides would cause most injury to the wheat that has been cracked the most. The results do not indicate that any one variety is injured more than another. Other factors, such as maturity when harvested, viability of the seed, conditions under which the crop was

raised, influence the amount of seed injury. With the methods used in these experiments the injury from the use of copper sulphate is much greater than when formaldehyde is used.

Experiments to Determine How to Reduce Seed Injury

Since it was found that the per cent of injury ranged from nothing to over 80 per cent, methods to offset some of this reduction in germination were tried. In the first series, both presoaking in water and lime treatment were tried. Eight samples of Pacific Blue Stem were used. In treatment one, the ordinary copper sulphate treatment 1–5 (1 pound copper sulphate to 5 gallons of water), for ten minutes, was used. In treatment two, the wheat was first soaked in water for ten minutes, then kept moist for six hours, and finally treated with copper sulphate 1–5, for ten minutes. In treatment three, the operation was the same as for two, except that following the copper sulphate treatment the wheat was given a lime bath (1 pound to 10 gallons water for three minutes), and dried over night before planting. Finally, in treatment four, the presoaking was eliminated and the wheat dipped in copper sulphate 1–5 for ten minutes, and then dipped in lime water. Reference to table 2 will show the beneficial results of combining presoaking with lime. Since this method is not practical on extensive wheat farms, this method of reducing seed injury was not studied by further experiments. Table 2 gives the results.

TABLE 2

Effects of certain variations in copper sulphate seed treatment on germination of Pacific Blue Stem wheat

SAMPLE NO.	GERMINATION IN PER CENT FOLLOWING TREATMENT				
	CONTROL[1]	NO. 1[1]	NO. 2[1]	NO. 3[1]	NO. 4[1]
1	82.0	27.5	60.0	45.7	77.5
2	94.5	27.5	65.0	53.0	94.0
3	90.5	26.5	66.0	57.5	94.5
4	92.5	25.5	77.0	66.6	88.5
5	92.0	5.0	66.0	22.5	83.5
6	64.0	28.0	38.0	55.5	82.0
7	89.5	43.0	79.0		
8	94.5	45.0	92.0		

[1] Control = No treatment
No. 1 = Copper sulphate, 1 lb. to 5 gal. water, 10 min.
No. 2 = Copper sulphate, 1 lb. to 5 gal. water, 10 min.; limed.
No. 3 = Presoaked in water 10 min.; kept moist 6 hours; treated copper sulphate solution 1–5, 10 min.
No. 4 = Presoaked in water 10 min.; kept moist 6 hours; treated copper sulphate solution 10 min.; limed; dried over night.

It will be noticed from the results in table 2 that the difference in favor of liming is very marked for all samples treated. This method of liming is not new and is extensively used in some parts of the world.

Among the farmers of eastern Washington it is commonly contended that it is impossible to kill wheat with copper sulphate solution no matter how strong the treatment or how long the immersion. For that reason, preliminary experiments were conducted using only one seed lot of Pacific Blue Stem wheat, 100 kernels in each test. Different strengths of copper sulphate were used ranging in strength from one pound to five gallons of water to one pound to one gallon of water, and for each solution ten, twenty, and thirty minute periods of immersion. A duplicate series was run in which the copper sulphate treatment was followed by the lime bath. Table 3 gives the results. Note that in all cases there is a reduction of seed injury by liming.

TABLE 3

Effects of certain variations of copper sulphate seed treatment on germination of Pacific Blue Stem wheat; strength of solution, duration of immersion and liming being varied

COPPER SULPHATE SOLUTION	PERCENTAGE OF GERMINATION FOLLOWING IMMERSION						
	NOT TREATED	10 MIN.		20 MIN.		30 MIN.	
		UNLIMED	LIMED	UNLIMED	LIMED	UNLIMED	LIMED
Control	97						
$CuSO_4$ 1 lb.–5 gal.		78	80	61	84	82	91
$CuSO_4$ 1 lb.–2 gal.		74	83	61	84	67	83
$CuSO_4$ 1 lb.–1 gal.		63	81	45	84	25	69

Liming After Treating With Formaldehyde

While the practice of liming after treating wheat with copper sulphate has been practiced for many years, it was not until the spring of 1918 that similar treatment following the use of formaldehyde was brought to our attention. At that time, treated and untreated samples of wheat were collected from farmers of central Washington for germination, in order to make tests for seed injury. Among the samples sent in was a set treated by County Agent, T. S. Brown of Franklin County, in which one sample had been limed after treatment for ten minutes with a standard 1–40 formaldehyde solution. A very beneficial effect was noted in the limed sample.

In the fall of 1919, and the spring of 1920, field demonstrations were planted in Franklin County by County Agent Brown and the writer. The following four treatments were employed using 100 pounds of wheat

for each lot: (1) copper sulphate 1–5 for ten minutes; (2) copper sulphate 1–5 for ten minutes, then dipped in lime water 1–10 for ten minutes; (3) formaldehyde 1–40 for ten minutes; (4) formaldehyde 1–40 for ten minutes, then dipped in lime water 1–10 for ten minutes. One demonstration was seeded in the fall of 1919 and five in the spring of 1920. Each farmer sowed the specially treated seed at the same rate that he used for his general farm seeding. Samples were sent to Pullman for laboratory germination tests. The results in table 4 show a reduction of injury following the lime bath, after both copper sulphate and formaldehyde treatments. The wheat for laboratory tests was planted in soil in flats, in the greenhouse at Pullman, Washington.

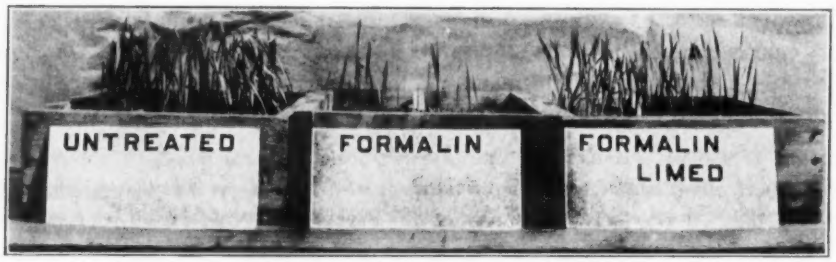


FIG. 1. BENEFICIAL EFFECT OF LIME FOLLOWING TREATMENT OF WHEAT WITH FORMALDEHYDE

FIG. 2. BENEFICIAL EFFECT OF LIME FOLLOWING TREATMENT OF WHEAT WITH BLUESTONE

The treatment of wheat in the field was carried out as accurately as possible under field conditions. In order to get more accurate results, some of the untreated samples were treated with solutions carefully prepared in the laboratory. An additional sample was dipped in the lime bath only. Two hundred seeds were used in each 12 x 18 inch flat for the field treated seed, and one hundred seeds in similar flats for the seed treated in the laboratory.

TABLE 4

Germination of Early Baart wheat following various seed treatments

SAMPLE NO.	WHERE TESTED	GERMINATION IN PER CENT AFTER TREATMENT					
		CONTROL[1]	NO. 1[1]	NO. 2[1]	NO. 3[1]	NO. 4[1]	NO. 5[1]
1	Field	55.0	49.5	63.0	55.0	69.0	
1	Lab.	79.0	19.0	58.0	63.0	90.0	88.0
2	Field	93.0	57.0	78.0	48.0	95.0	
2	Lab.	91.0	11.0	57.0	69.0	96.0	96.0
3	Field	78.5	38.5	72.5	12.5	68.5	
3	Lab.	85.0	58.0	70.0	70.0	83.0	87.0
4	Field	99.0	90.5	94.5	86.5	94.5	
4	Lab.	97.0	61.0	75.0	93.0	96.0	100.0
5	Field	81.5	57.5	71.5	48.0	76.5	
5	Lab.	81.0	39.0	68.0	70.0	95.0	92.0

[1] Control—Not treated
No. 1—Copper sulphate, 1 lb. to 5 gal., 10 min.
No. 2—Copper sulphate, 1 lb. to 5 gal., 10 min.; limed.
No. 3—Formaldehyde, 1 pt. to 40 gal., 10 min.
No. 4—Formaldehyde, 1 pt. to 40 gal., 10 min.: limed.
No. 5—Limed, 1 to 10, 3 min.

As soon as the plants in the field plots had sent out the second leaves counts were made to determine the stand. Using a yard length in a drill row as a unit, the writer, selecting places at random, made ten counts totaling thirty feet of drill row for each plot. The County Agent, Mr. Brown, made similar counts. These results were tabulated and an average made of the twenty counts. The data in table 5 represent the average number of plants per three feet of drill row. It will be noted that the beneficial effects of liming were more pronounced in the field

TABLE 5

Field stand of unlimed and limed, treated wheat. Average number plants in three feet of drill row. Average based on twenty counts per plot. Franklin County. Plots on farm No. 2 sown fall, 1919, others spring, 1920

FARM NO.	AVE. NO. PLANTS IN 3 FEET OF DRILL				PER CENT IMPROVEMENT FROM LIMING	
	COPPER SULPHATE TREATED SEED		FORMALDEHYDE TREATED SEED		COPPER SULPHATE TREATED SEED	FORMALDEHYDE TREATED SEED
	UNLIMED	LIMED	UNLIMED	LIMED		
1	13.5	17.5	16.9	34.1	29.9	42.5
2	6.0	9.9	7.1	10.0	65.0	42.2
3	15.6	26.8	18.6	26.5	71.8	42 4
4	21.9	33.7	22.8	31.0	53.8	35.9
5	12.8	21.0	14.6	22.1	64.0	51.3
6	16.1	29.6	19.3	29.4	83.3	52.3
Ave.	14.3	23.1	16.5	25.5	61.3	44.4

plots than in the greenhouse tests. The plants from the lime-treated seed were more vigorous and had a better developed root system than those from the unlimed seed. This enabled them to better withstand the severe dust and sand storms of this section of the state. Unlimed wheat in plots adjacent to the limed plots were rather badly blown out of the ground.

Farmers continually complain of seed injury after using formaldehyde. In order to test the killing power of formaldehyde, wheat was treated in solutions ranging from one pound to thirty gallons of water to one pound to five gallons of water. The wheat was dipped for ten and thirty minute periods. Table 6 gives the results.

TABLE 6

Effects of certain variations af formaldehyde seed treatment on germination of Pacific Blue Stem wheat.

FORMALDEHYDE SOLUTION	PERCENTAGE OF GERMINATION FOLLOWING TREATMENT		
	UNTREATED	10 MIN.	30 MIN.
Control	95		
1 pt. to 30 gal.		52	77
1 pt. to 15 gal.		54	61
1 pt. to 10 gal.		16	14
1 pt. to 5 gal.		0	0

Relation of Soil Moisture to Formaldehyde Injury

It is a known fact in the Pacific Northwest that formaldehyde treated wheat planted in a dry soil shows considerable seed injury. In order to procure definite data on this point, two samples of 400 seeds each of treated Turkey Red wheat were planted; one part of each sample was watered at once after planting; the other planted and left two days in dry soil, and then watered. Sample 1 gave 83 per cent germination in moist soil and only 44 per cent in soil watered after 2 days. Sample 2 gave 35 per cent and 29.5 per cent respectively.

Finally experiments were made to determine the effect of liming in reducing seed injury. By using different strengths of solution and different durations of immersion followed by immediate watering in one series and watering only after three days in the other series. The solution marked 1–1, consisted of equal parts of commercial formaldehyde solution and water, while the other solutions were one pint of formaldehyde to ten, twenty, thirty, and forty gallons of water respectively. Nine, 100-seed lots of untreated wheat were used in each series.

TABLE 7

Germination of Early Baart wheat, not treated and treated different periods with different strengths of formaldehyde solution; planted in moist soil and in dry soil, watered 3 days after planting.

STRENGTH OF SOLUTION	SOIL MOIST OR DRY AND WATERED AFTER 3 DAYS	GERMINATION IN PER CENT				
		NOT TREATED	TREATED 10 MIN.		TREATED 30 MIN.	
			LIMED	NOT LIMED	LIMED	NOT LIMED
Controls	Soil moist	73				
	Soil dry	72				
1-1	Soil moist		7.5	4.5	2.0	0.0
1-1	Soil dry		2.0	0.0	0.0	0.0
1-10	Soil moist		49.0	34.5	35.0	8.0
1-10	Soil dry		10.0	6.5	11.0	6.0
1-20	Soil moist		62.5	41.0	57.0	34.0
1-20	Soil dry		29.5	14.0	17.0	15.0
1-30	Soil moist		73.5	48.5	52.0	48.0
1-30	Soil dry		55.0	37.5	41.0	21.0
1-40	Soil moist		72.5	53.0	78.0	69.0
1-40	Soil dry		74.0	53.0	69.0	33.0

It will be noted that in every case where seed is limed after treatment with formaldehyde that the percentage of germination is increased. The most marked effects in reducing seed injury were obtained with grain treated with the standard strengths of formaldehyde.

SUMMARY AND CONCLUSIONS

1. Due to the dry atmosphere at the time of harvest in the state of Washington, the wheat kernels are generally dry and brittle at the time of threshing. When such wheat is threshed in machines, with high speed cylinders, the seed coats are badly cracked.

2. Subsequent treatment of this wheat with fungicides causes a high percentage of injury to germination.

3. The injury to seed wheat varies for the different lots of a given variety except that injury is general for samples obtained from various wheat sections of the Pacific Northwest, and varies for the different lots of a given variety.

4. This injury can be overcome by presoaking in water before using a fungicide followed by dipping in lime. This, however, is not practical on a large scale.

5. The most practical method to use in the control of seed injury is to dip the wheat in lime water after treating with copper sulphate or formaldehyde.

STATE COLLEGE OF WASHINGTON
PULLMAN, WASH.

LITERATURE CITED

(1) ANONYMOUS. Germination of wheat and oats treated for smut. Wyoming Agric. Exp. Sta. Ann. Rpt. **10** (1899–1900): 1–3. 1900.

(2) BOLLEY, H. L. New studies upon the smut of wheat, oats and barley, a resumé of treatment experiments for the last three years. North Dakota Agric. Exp. Sta. Bull. 27: 109–162. *13 fig.* 1897.

(3) BRAUN, HARRY. Presoak method of seed treatment: A means of preventing seed injury due to chemical disinfectants and of increasing germicidal efficiency. Jour. Agric. Res. **19**: 363–392. *9 fig., pl. 69–82.* 1920. Literature cited, p. 392.

(4) BRITTLEBANK, C. C. Effect of formalin and copper sulphate pickle on the germination of wheat. Jour. Dept. Agric. Victoria **11**: 473–476. *2 fig.* 1913.

(5) BURMESTER, Hermann. Vergleichende Untersuchungen über den Einfluss der verschiedenen Samenbeizmethoden auf die Keimfähigkeit gebeizten Saatgutes und ihre pilztötende Wirkung. Zeitschr. Pflanzenkrankh. **18**: 154–187. 1908.

(6) CRANEFIELD, F. The influence of formalin on the germination of oats. Wisconsin Agric. Exp. Sta. Ann. Rept. **18**: (1900–01) 327–335. *Fig. 101–106.* 1901.

(7) ——— The influence of formaldehyde on the germination of oats. Wisconsin Agric. Exp. Sta. Ann. Rpt. **19** (1901–02): 268–272. 1903.

(8) CROZIER, A. A. On the effects of certain fungicides upon the vitality of seeds. Jour. Mycol. **6**: 8–11. 1890.

(9) DAVID, ST. Zur Frage über die Wirkung des Formaldehyds auf Getreidesamen und Brandsporen. Sitzungsber. Naturforsch. Ges. Univ. Dorpat. **12**: 202–204, 222–247. 1899. In Russian. German Resumé, p. 202–204.

(10) DEMOUSSY, E. La germination des graines de blé traités au sulfate de cuivre. Ann. Agron. **27**. 257–261. 1901.

(11) EVANS, W. H. Copper sulphate and germination. Treatment of seed with copper sulphate to prevent the attacks of fungi. United States Dept. Agric. Div. Veg. Physiol. and Pathol. Bull. 10. *24 p.* 1896.

(12) FALKE, FR. Die Dehne'sche Desinfektionsmaschine für Saatgetreide. Landw. Wochenschr. Sachsen, **2**: 365–367, 374–375. 1900.

(13) HENDERSON, L. F. Experiments with wheat and oats for smut. Idaho Agric. Exp. Sta. Bull. 53. *15 p.* 1906.

(14) HILTNER, L. AND G. GENTNER. Warum sind Winterroggen und Winterweizen im Herbste 1911 vielfach schlecht aufgelaufen? Illustr. Landw. Zeitg. **32**: 29–30. 1912.

(15) HITCHCOCK, A. S. AND M. A. CARLTON. The effect of fungicides upon the germination of corn. Kansas Agric. Exp. Sta. Bull. 41: 63–79. 1893. Bibliography, p. 76–78.

(16) HURST, R. J. Bunt and germination experiments. Agric. Gaz. New South Wales. **22**: 749–752. 1911.

(17) D'IPPOLITO, G. Azione di alcune sostanze anticrittogamiche sulla energia germinativa di alcune varietà di frumento e di avena. Staz. Sper. Agrar. Ital. **43**: 735–757. 1910. Bibliografia dell'argomento, p. 755–757.

(18) JOHNSON, J. C. Influence of "pickling" on the germination of cereals. Jour. Bd. Agric. London. **20**: 120–124. 1913.

(19) JONES, L. R. The effects of various fungicidal treatments upon the vitality of seed corn. Vermont Agric. Exp. Sta. Ann. Rept. **5** (1891): 138–141. 1892.

(20) KIESSLING, L. Uber Keimschädigungen durch Beizung mit Formalin. Illustr. Landw. Zeitg. **58**: 253–254, 262–263. 1918.

(21) KINZEL, WILHELM. Ueber die Einwirkung des Formaldehyds auf die Keimkraft Landw. Versuchsst. **49**: 461–466. 1898.

(22) KÖCK, GUSTAV. Ueber die Bedeutung des Formaldehyds als Pflanzenschutzmittel, speziell über den Wert desselben als Beizmittel. Zeitschr. Landw. Versuchssta. Oesterreich. **9**: 811–843. *1 pl.* 1906. Bibliographical footnotes.

(23) KUDELKA, F. Ueber den Einfluss der Kupfervitriollösung auf die Keimfähigkeit des gequellten Weizens. Biedermann's Centralbl. **10**: 192–194. 1876.

(24) LAKON, GEORG. Notiz über die Wirkung des Heisswasserverfahrens auf die Keimfähigkeit der Getreidefrüchte. Zeitschr. Pflanzenkrankh. **27**: 18–25. 1917.

(25) LESAGE, PIERRE. Sur l'attitude de quelques semences soumises à l'action de solutions diverses de sulfate de cuivre. Bull. Soc. Sci. et Méd. Ouest. **21**: 129–132. 1912.

(26) MCALPINE, DANIEL. Effect of formalin and bluestone on the germination of seed wheat. Dept. Agric. South Australia Bull. 12. *21 p.* 1906.

(27) MAERCKER, M. Ueber die Beeinträchtigung der Keimkraft der Gerste durch Einquellen in Schwefelsäure. Magdeburger Zeitg. 1887. Not seen. Abstract in Just's Bot. Jahresber. **15** (1887): 139. 1889.

(28) MEZENTZOV, B. Influence of the remedies employed in combating smut on the germination of seeds. Yuzh. Russ. Selsk. Khoz. Ghaz. 1902, no. 42. Not seen. Abstract *in* Zhur Opuitn. Agron. (Jour. Exp. Landw.) **3**: 738–739. 1902. In Russian. Abstract *in* Exp. Sta. Rec. **14**: 1081. 1903.

(29) MOLZ, EMIL. Ueber das Totbeizen des Saatgutes und dessen Verhütung. Landw. Wochenschr. Sachsen **18**: 79–81. 1916.

(30) MÜLLER, H. C. AND EMIL MOLZ. Uber den Steinbrand des Weizens. Fühlings Landw. Zeitg. **63**: 204–214. 1914.

(31) ——— ——— Versuche zur Bekämpfung des Steinbrandes bei dem Winterweizen mittels des Formaldehydverfahrens. Fühlings Landw. Zeitg. **63**: 742–752. 1914.

(32) ——— ——— AND O. MORGENTHALER. Beizempfindlichkeit des Getreides von der Ernte 1911. Deutsch. Landw. Presse. **39**: 234. 1912.

(33) PERNOT, E. F. A preliminary bulletin on the prevention of smut on oats. Oregon Agric. Exp. Sta. Bull. 63. *9 p.* 1900.

(34) PICCHIO, G. La germinabilita del frumento tratto con alcuni anticritta ganici ed insettidi. Coltivatore **59**: 435–439. 1913.

(35) PIERRE, ISODORE. Faits relatifs au chaulage, au vitriolage, à l'étuvage et à la germination du blé. Ann. Agron. **2**: 176–181. 1876.

(36) RICHARDSON, A. E. V. Bunt tests 1909. Jour. Dept. Agric. South Australia **13**: 491–494. 1910.

(37) RIEHM, E. Getreidekrankheiten und Getreideschädlinge. . . Centralbl. Bakt. Parasitenk u. Infektionskrankh. II. **39**: 81–107. 1913. Literatur, p. 103–107.

(38) SCHELLENBERG, H. C. Machinendrusch und handdrusch in ihren Beziehungen zur Qualität des Saatgutes bei unsern Getreidearten. Landw. Jahrb. Schweiz. **13**: 152–168. 1899.

(39) STEVENS, F. L. Experiments upon the effect of formalin upon the germination of oats. North Carolina Agric. Exp. Sta. Ann. Rept. **31** (1908): 30–36. 1909.

(40) STEWART, ROBERT AND JOHN STEPHENS. The effect of formalin on the vitality of seed grain. Utah Agric. Exp. Sta. Bull. 108: 145–156. 1910.

(41) SUTTON, G. L. AND J. T. PRIDHAM. The effects of some fungicides recommended for the prevention of "stinking smut" (bunt) on the germination of wheat seeds. Agric. Gaz. New South Wales **18**: 235–253. *10 illus.* 1907.

(42) SUTTON, G. L. AND R. G. DOWNING. Some experiments with fungicides used for the prevention of "stinking smut" (bunt), Cowra, 1909. Agric. Gaz. New South Wales **21**: 382–387. 1910; **22**: 341–357. 1911.

(43) WALLDEN, J. N. Tröskada å hevete och råg samt dess inflytande på känslighsten för betning och lagring. [Damage caused by threshing of wheat and rye and its influence upon sensibility to treatment with fungicides and to storage]. Sveriges Utsädesf. Tidskr. **26**: 24–47. *1 fig., 1 pl.* 1916.

(44) WINDISCH, RICHARD. Ueber die Einwirkung des Formaldehyds auf die Keimung. Landw. Versuchsst. **49**: 223–226. 1897.

(45) WOOLMAN, H. M. Stinking smut in wheat. Washington Agric. Exp. Sta. Pop. Bull. 73. [8] *p.* 1914.

——— Seed-coat injury and viability of seeds of wheat and barley as factors in susceptibility to molds and fungicides. Jour. Agr. Sci. **21**: 99–122. 1921.

CONTROL OF STEM GIRDLE OF SPRUCE TRANSPLANTS CAUSED BY EXCESSIVE HEAT

C. F. KORSTIAN AND N. J. FETHEROLF

WITH THREE FIGURES IN THE TEXT

With the transplanting of approximately a hundred thousand two and three-year old seedlings of Engelmann spruce (*Picea engelmanni*) and Norway spruce (*Picea excelsa*) in 1916 and 1917 at the Cottonwood Nursery, which is located in the Wasatch Mountains 25 miles southeast of Salt Lake City, Utah, at an elevation of 7400 feet, stem girdle became quite serious. Hartley[1] observed and studied this form of injury in this nursery in 1915. He attributed it to heat but stated that further experiments were necessary as no efficient method of control had been discovered.

The seedlings made normal growth and development while in the seed beds, remaining green throughout the winter under the deep snow which covered them for approximately six months. They were shaded during the summer while in the seed beds but the transplant beds were not shaded. From four to five weeks after transplanting, some of the transplants began to turn yellow and ultimately died. Observations were made on two transplant beds which were located side by side, had the same soil conditions, were transplanted at the same time by the same general methods and received the same subsequent treatment. On one of the beds the losses were much heavier than on the other bed, as much as 32.8 per cent greater.

A careful study of the conditions revealed the fact that in the bed showing the heavier loss the trees inclined slightly to the north while in the bed having little or no loss the trees inclined to the south. The difference in the direction of incline was due to the direction in which the transplanting operation proceeded across the beds. In the open trench method which has been commonly used at the Cottonwood Nursery, the soil is removed with a spade, making a V-shaped trench one side of which is nearly vertical. As a matter of fact, however, this so-called vertical side against which the trees are planted has a slight slope in the opposite direction to that in which the transplanting proceeds, or toward that portion of the bed already transplanted.

An examination of the dead trees in the bed in which the transplants leaned slightly to the north showed that a high percentage of them were

[1] Hartley, Carl. Non-parasitic stem lesions on seedlings. Phytopathology **6**: 308–309. 1916.

——— Stem lesions caused by excessive heat. Jour. Agric. Research **14**: 595–604. 1918.

affected by stem girdle. Lesions on both dead and living transplants were found most commonly on the south side of the stem extending from about 0.1 inch below the soil surface to 0.3 inch above. However, the greatest injury was noted at the surface of the soil indicating that the lesions apparently began at this point and as they developed extended upward and around the stem. Not until the stem was girdled were lesions found on the north sides of the stems, and in such cases the lesion extended farther up the stem on the south side than on the north.

Working on these premises in the 1918 transplanting, the greater part of the trees were put in the beds with a slight incline to the south, thereby reducing losses to 6 per cent as compared with 22.2 per cent for the previous year. Transplanting in the same manner in 1919 gave a similar reduction in losses. Figure 1 shows two beds with the transplants in-

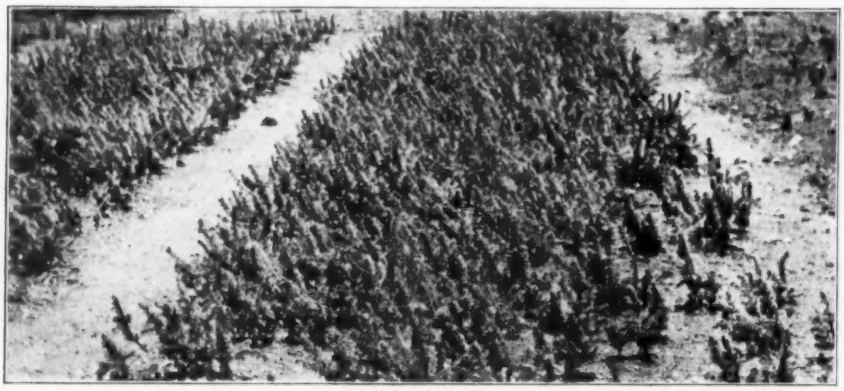


Fig. 1. Engelmann spruce transplant beds in which the trees incline to the north, showing open stand of 3–1 transplants due to heavy loss by stem girdle.

TABLE 1

Loss of Engelmann spruce and Norway spruce transplants due to stem girdle during the first growing season on different aspects and with the trees inclined in different directions

SPECIES	ASPECT	DIRECTION OF INCLINE OF TREES.	PER CENT LOSS JUNE 2 TO SEPT. 29, 1919
Engelmann spruce	Level	South	3.7
" "	"	North	30.6
" "	"	Vertical	11.4
" "	South	"	7.0
" "	North	"	2.4
Norway spruce	Level	South	8.5
" "	Level	North	33.5

clined to the north in which loss due to stem girdle was excessive. Figure 2 shows the adjacent beds in which the transplants inclined to the south and in which loss due to stem girdle was very slight.

Pool[2] has shown that surface insolation is greatly affected by aspect

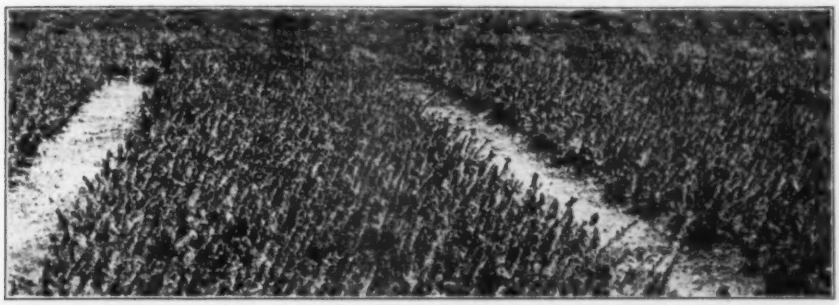


Fig. 2. Engelmann spruce transplant beds adjacent to those shown in Figure 1. The transplants incline to the south, which accounts for the good stand of normal density.

and by the presence of even a sparse vegetative cover. The temperature of the surface of the fine sandy soil in a "blowout" facing the sun in the sandhills of northwestern Nebraska was found to be 145° F., while at the same time the temperature of the soil surface on a northern aspect was 91.5° F. He also found a great difference between the temperature of the soil surface and the temperature a few inches below the surface.

It is well known that although the temperature of the air in the mountains is not unusually high, yet the heat of rocks and gravel exposed to direct insolation at high altitudes is known to be excessive. To further confirm the belief that stem girdle is caused by excessive temperatures of the soil surface and that it can be definitely controlled by transplanting in such a manner that the trees incline slightly to the south, an experiment was initiated in 1919 and repeated in 1920. Lots of 200 trees each of 3–0 Engelmann spruce and Norway spruce were transplanted on June 2, 1919, under varying conditions of aspect and inclination of tree. The results of the experiment are summarized in table 1.

The loss is very much greater where the trees lean slightly to the north than in the beds where the trees were inclined toward the south. As would naturally be expected, a greater loss occurred in the trees planted perpendicularly to the surface of the soil than among those inclined toward the south, but the loss was less than among those having an incline to the north. Trees standing vertically on a southern aspect showed a greater loss than those standing vertically on a northern aspect.

[2] Pool, Raymond J. A study of the vegetation of the sandhills of Nebraska. Minn. Bot. Studies, **4**: 185–312. 1914.

Upon several occasions during the summers of 1919 and 1920, temperatures of the upper one-fourth inch of the surface soil were taken simultaneously in the Engelmann spruce transplant beds in which the trees were standing vertically, slightly inclined to the north, and slightly inclined to the south, all being on level ground. Temperatures of the surface soil on July 2 and August 15, 1919, days on which a few clouds were to be seen but on which the sun was shining clearly at the time of observation, and those observed on July 10 and August 16, 1920, two of the warmest clear days of the season, are recorded in table 2.

TABLE 2

Temperatures of surface soil in Engelmann spruce transplant beds

DATE	TIME	TEMPERATURES OF SOIL SURFACE IN DEGREES F.		
		TREES INCLINED TO SOUTH	TREES VERTICAL	TREES INCLINED TO NORTH
July 2, 1919	1:10 P.M.	89.8°	90.8°	102.5°
"	1:20 P.M.	99.5	101.8	111.0
"	1:30 P.M.	101.3	104.6	111.5
	Average	96.9	99.1	108.3
Aug. 15, 1919	4:00 P. M.	109.0	110.0	112.5
"	4:30 P.M.	109.0	110.5	114.0
"	5:00 P.M.	108.0	110.0	111.0
	Average	108.6	110.2	112.5
July 10, 1920	2:45 P.M.	103.8	107.7	130.2
"	2:45 P.M.	104.0	108.9	127.4
	Average	103.9	108.4	128.8
Aug. 16, 1920	1:30 P.M.	110.0	119.4	123.1
"	1:30 P.M.	111.4	121.0	127.5
	Average	110.7	120.2	125.3

Unfortunately the theremometers available in 1919 were not graduated to read above 114° F., which made it impossible to secure readings on the hottest days of the season. However, the data for 1919 show the relative differences which may be expected under the different conditions. In 1919 a loss from stem girdle of 3.7 per cent occurred when the 3-1 Engelmann spruce transplants inclined slightly to the south, 11.4 per cent when standing vertically, and 30.6 per cent when they leaned to the north. In Norway spruce transplants of the same age there was a loss of 8.5 per

cent when the trees inclined to the south and a loss of 33.5 per cent when leaning to the north, all of which was due to stem girdle. The same aged Engelmann spruce similarly transplanted were used in 1920. The summer of 1920 was more unfavorable for stem girdle than that of 1919, because of greater rainfall, more cloudy weather, and the fact that high temperatures were of shorter duration. In 1920 no loss occurred in the beds with the transplants standing vertically or leaning to the south, while a loss of only 4 per cent occurred in the case of the transplants inclined to the north, of which an additional 4.8 per cent were unhealthy because of stem girdle.

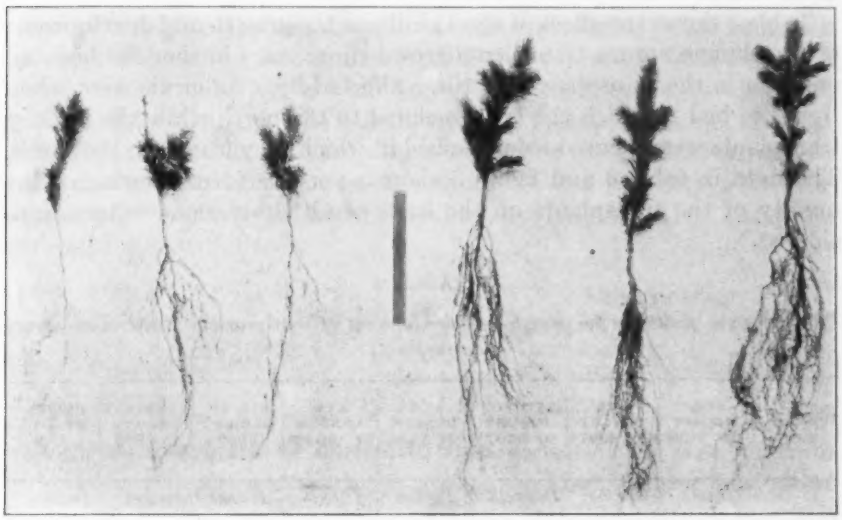


Fig. 3. Typical 3-1 Engelmann spruce transplants grown three years in the seed bed and one year in the transplant bed; those to the left of the rule are affected with stem girdle, while those to the right are healthy. The apparent constrictions due to stem girdle may be seen on the injured transplants.

From table 2 it appears that the variation in temperature at the base of the trees is due to the angle at which the sun's rays strike the tree. The angle of incidence of the sun's rays on trees leaning north is small and on those leaning south is large, which accounts for the varying intensity of insolation; it being high on trees inclining north and low on those which incline to the south. In soils containing a considerable admixture of sand or gravel, as is the case with the Cottonwood Nursery soil, radiation from the small stones and gravel is high. In the case of trees standing vertically the insolation and effect of radiation are not so

great as in the case of those trees inclined to the north, because of the changed angle and the shade which the top gives the lower part of the stem even on the south side. The bases of the trees which are inclined to the south are subjected to much less insolation and radiation from the surface of the soil, on account of the shade which the top and the stem afford not only to the base of the stem but also to the surface soil immediately to the south. The evidence pointing to a heat relationship is further strengthened by the fact that all of the cases of injury arising from stem girdle were in transplants where the soil was exposed to the sun. Stem girdle was not found in dense stands where the bases of the trees were shaded.

Table 3 shows the effect of stem girdle on the growth and development of Engelmann spruce transplants grown three years in the seed bed and one year in the transplant bed; those affected by stem girdle were taken from the bed in which the trees inclined to the north while the healthy transplants were secured from the bed in which they leaned to the south. The data in table 3 and figure 3 show a very decided lowering of the quality of the transplants on the basis of all the various criteria considered.

TABLE 3

Effect of stem girdle on the growth and development of four-year-old Engelmann spruce transplants

CONDITION	AVE. WEIGHT OF TOPS	AVE. WEIGHT OF ROOTS	RATIO OF WEIGHT OF ROOT TO WEIGHT OF TOPS	AVE. LENGTH OF TOPS	AVE. LENGTH OF ROOTS	DIA. OF STEM AT ROOT COLLAR	TERMINAL GROWTH IN 1920	LENGTH OF 1 YR OLD LEAVES
	Grams	*Grams*	*Per cent*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Stem-Girdled	1.59	0.44	36.1	3.4	8.3	0.07	0.63	0.32
Healthy	3.85	1.93	45.0	5.3	10.4	0.15	1.46	0.41

From these experiments it is very evident that stem girdle is caused by excessive heat and that it can be eliminated in normal seasons or reduced to a negligible amount in seasons having predominatingly high temperatures. Frequent watering has a slight preventive effect in lowering the temperature of the surface soil, but the results are only of a temporary nature. The control of stem girdle by inclining the trees slightly to the south at the time of transplanting is by far the best and most efficient method of control which has been discovered.

FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE.
WASHINGTON, D. C.

NOTE ON THE HYDROGEN-ION CONCENTRATION OF POTATO DEXTROSE AGAR AND A TITRATION CURVE OF THIS MEDIUM WITH LACTIC ACID

E. F. Hopkins[1]

With One Figure in the Text

The widespread use of potato dextrose agar as a culture medium by plant pathologists and the frequent practice of adding lactic acid to it to prevent bacterial contamination in the course of isolation work would make it seem worth while to report a study made, incidental to other investigations, on the reaction of this culture medium. The reaction is expressed as pH according to Sörensen (3). The colorimetric method of Gillespie (1, 2) was used and color and turbidity were compensated by means of a method devised by Walpole (4). The tubes were arranged as follows:

Culture Medium	Culture medium + indicator
Color Standard	Water

A comparison block as illustrated by Gillespie (1, 2) was found to be very convenient in making the readings. The indicator was added to the agar while it was still liquid and both this tube and the comparison tube allowed to cool to room temperature before reading. No difficulty was experienced in making comparisons with the standards.

PREPARATION AND REACTION OF THE MEDIUM

The following formula was used in the preparation of all lots of the potato-dextrose agar:

Pared potatoes	200 gms.
Dextrose	10 gms.
Agar	20 gms.
Water (tap)	1000 cc.

The potatoes were cut in small cubes and cooked with about three-fourths of the water in a double boiler until "done" but not disintegrated. The potato broth was then filtered through cheese cloth. A good grade of pure granulated dextrose and Difco agar were used. Before the agar was added to the potato broth it was placed in a cheese cloth sack and washed in running water for about an hour. After the agar and dextrose were added to the potato broth and the whole made

[1] Published by permission of the Director of the Missouri Experiment Station.

up to volume, the medium was steamed in an Arnold sterilizer for one hour to coagulate the precipitate. It was then filtered through absorbent cotton, tubed and sterilized at fifteen pounds pressure for twenty minutes. A good clear medium resulted in all cases.

In one preparation hydrogen-ion determinations were made at various stages to find out what change might be effected by any part of the process, with the following results:

Steps	pH
Potato broth	6.3
After the addition of dextrose	6.9
After the addition of agar and steaming for one hour	7.4
After sterilizing	6.9

The values obtained in testing preparations made by four different workers from five different lots of potatoes are shown in table 1. Sample No. 9, made from new potatoes, shows about the same reaction as the other samples prepared from old ones.

TABLE 1

The hydrogen-ion concentration of potato agar

SAMPLE	pH		
	BROM THYMOL BLUE	PHENOL RED	AVERAGE
1	6.9	...	6.9
2	7.3	...	7.3
3	7.4	7.3	7.35
4	7.4	7.4	7.4
5	7.4	7.2	7.3
6	7.4	...	7.4
7	7.5	7.6	7.55
8	7.7	7.8	7.75
9	7.3	7.4	7.35

The above data show that without any adjustment of reaction a medium which is practically neutral is obtained. The average of these nine samples gives the value pH 7.37 ± .05. This accounts for the fact that it is an excellent substratum for many species of bacteria. It is interesting to note that such strenuous treatment as steaming for one hour in the Arnold followed by autoclaving causes only such a small change in the reaction. One might expect the sugar to break down and cause a marked shift in reaction towards the acid side. Slight if any change in color indicated furthermore that the sugar did not break down.

EFFECT OF LACTIC ACID ON THE REACTION OF THE MEDIUM

The change in reaction experienced on adding lactic acid to potato agar besides showing the reason for the inhibition of bacterial growth should show also the amount of buffer action exhibited by this medium.

A solution of lactic acid (50 per cent by volume) was prepared, and a varying number of drops of it added to tubes containing 20 cubic centimeters of potato agar and the pH determined. As a previous experiment had shown that one drop of this strong solution had shifted the pH from 7.0 to 4.5 a solution one-eighth as strong was prepared and used in the same manner. Values were thus obtained between 7.0 and 4.5.

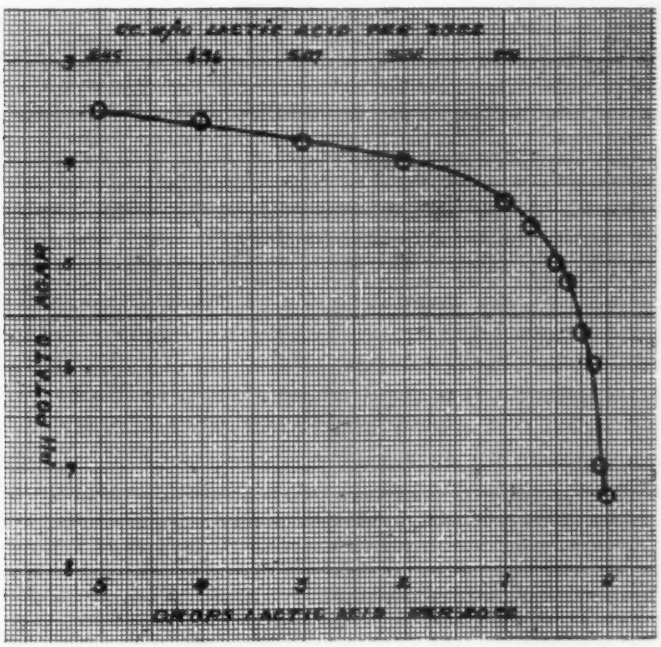


FIG. 1. A titration curve of potato dextrose agar with 50 per cent lactic acid.

Although it is not necessary to know the absolute concentration of the lactic acid as the hydrogen-ion concentration is usually determined later, titrations were made of the lactic acid solution used. The same pipette was used for dropping the acid and was always held vertically. It was found on titrating 1, 2, 4 and 7 drops of the strong solution with N/5 NaOH in the presence of phenolphthalein that the average value of one drop was equivalent to 0.845 ± 0.004 cubic centimeters N/5 solution or 0.053 gm. lactic acid per drop. One cubic centimeter of the solution was then titrated and required 35.62 cubic centimeters N/5 solution. This is equivalent to 0.6412 gm. lactic acid or the solution was about 7N. In table 2 the pH values obtained by varying the concentration of the acid are shown.

TABLE 2

The effect of lactic acid on the reaction of potato agar

Drops of 50% lactic acid	0	1/8	2/8	3/8	4/8	6/8	1	2	3	4	5
pH	7.3	6.0	5.7	5.2	5.0	4.65	4.4	4.0	3.8	3.6	3.5

These data are plotted as a titration curve (Fig. 1). The lactic acid is expressed both as drops of a 50 per cent solution and as cubic centimeters of an N/10 solution, and the acidity as pH. The shape of the curve shows that this culture medium exhibits considerable buffer action and also what values may be obtained. If one drop in 20 cubic centimeters shifts the acidity to pH 4.4 it is then clear why this procedure prevents the growth of certain organisms entirely and allows others to grow. A practical application is of course the common practice of preventing bacterial contamination. It may be suggested that where a fungus is sensitive to acid, a point could possibly be located where bacterial growth would be inhibited but still allow the development of the fungus. Differential isolation of fungi has been accomplished also by varying the acidity.

Another application is in the determination of the effect of hydrogen-ion concentration on the growth and spore production of fungi. Very uniform growth-acidity curves have been obtained by using poured plates of potato dextrose agar of varying acidity and expressing the amount of growth by means of the diameter of the colonies.

SUMMARY

The hydrogen-ion concentration of potato dextrose agar is easily determined colorimetrically and is quite constant. The average for nine different preparations gives the value pH 7.37 ± .05.

The effect of lactic acid on the reaction of this medium is presented as a titration curve and suggestions as to its application are made.

UNIVERSITY OF MISSOURI.

LITERATURE CITED

(1) GILLESPIE, L. J. Colorimetric determination of hydrogen-ion concentration without buffer mixtures, with especial reference to soils. Soil Sci. **9**: 115–136. *1 fig.* 1920. References, p. 135–136.

(2) ——— Colorimetric determination of titration curves without buffer mixtures. Jour. Amer. Chem. Soc. **42**: 742–748. *1 fig.* 1920.

(3) SÖRENSEN, S. P. L. Enzymstudien. II. Über die Messung und die Bedeutung der Wasserstoffionenkonzentration bei enzymatischen Prozessen. Biochem. Zeitschr. **21**: 131–304. *8 fig., 1 fold. pl.* 1909.

(4) WALPOLE, G. S. Chart presentation on recent work on indicators. Biochem. Jour. **5**: 207–214. *1 fold. chart.* 1911.

SOME FACTORS AFFECTING THE PRODUCTION OF APOTHECIA OF SCLEROTINIA CINEREA

WALTER N. EZEKIEL

INTRODUCTION

When stone fruits are rotted by *Sclerotinia cinerea* (Bon.) Schroeter, the sclerotia of the fungus develop in the fruits. The perfect, apothecial, stage is produced from these sclerotia, after the old mummied fruits have been on the ground for a certain length of time. This much has been known since 1902, when Norton (5) first described the apothecia. Pollock (7) has found that plum mummies ten years old are still capable of producing apothecia. But how soon after the decayed fruits fall to the ground apothecia may be produced, and what conditions favor or retard their development, have been in doubt.

Norton (6) stated that as far as he could judge, the apothecia that he found came only from mummied fruits over one year old. Working with buried plum and apple mummies, Valleau (10) found that no apothecia developed until the second spring. Similar results had been obtained by Aderhold and Ruhland (1, 2) with *S. fructigena* on apples and "*S. laxa*" on apricots. On the other hand, Reade (8), in a taxonomic description of "*S. fructigena*," states; "The fungus has been grown on artificial media from ascospores to ascospores again, and completes its life cycle in one year." Roberts (9) in an experiment performed the same season as the work presented in this paper, found that apothecia could develop in less than one year.

The assumption that burying mummies would prevent the production of apothecia has been the basis of the general recommendation to plow brown-rot mummies under. This was advocated by Dandeno (4), for instance, because some decayed plums he buried did not produce apothecia. Brooks and Fisher (3) observed that most of the apothecia in an orchard which they inspected came from mummies near the surface of the soil.

Experiments were begun in July, 1920, to throw light on some of these points. The specific purposes were to determine: 1, the effect of various conditions on the production of apothecia; and 2, if a dormant period of over a year is necessary before apothecia can be produced. The work was done with Prof. J. B. S. Norton, at the Maryland Experiment Station.

TABLE 1

Summary of series 1, fruits inoculated with Sclerotinia cinerea July 22, 1920 and distributed as indicated, Aug. 20. (The symbols A, B, C, D, and E, used here, are explained below).

LOT NUMBER	NUMBER OF MUMMIES IN LOTS		PLACED AT	TRANSFERED TO	DATE OF TRANSFER	APOTHECIA PRODUCED
	PLUMS	PEACHES				
1	105	30	C			
2	60	15	C	D	Dec. 11	
				E	Jan. 31	
3	60	15	C	D	Dec. 11	
4	30	—	D	E	Sept. 16	
5	60	15	D	C	Oct. 14	
				D	Dec. 9	
				E	Mar. 5	
6	30	—	D	E	Dec. 8	Jan. 13, 1921
7	30	—	D	E	Jan. 31	
8	240	30	D			
9	30	20	*			
10	30	15	A	E	Oct. 12	
11	30	15	A	E	Dec. 8	
12	30	15	A	E	Jan. 3	
13	1790	755	A			Mar. 14, 1921.
14	15	5	B	A	Jan. 3	
15	10	5	B	E	Jan. 3	
16	15	5	B	A	Jan. 31	
17	10	5	B	E	Jan. 31	
18	15	5	B	A	Mar. 5	
19	10	5	B	E	Mar. 5	
20	175	70	B			

* Lot 9 remained on table in laboratory.

EXPLANATION OF SYMBOLS USED IN TABLE 1.

A—Natural conditions. The location chosen was between two greenhouses, where the ground had been in sod for a number of years. Mummies were placed in covered trays (4′ 6″ × 2′ × 6″) of galvanized 1/4″ mesh wire hardware cloth, sunk four inches below the surface of the ground, leaving two inches above ground. They were filled level to the surface of the ground with a mixture of pure white sand and clay subsoil mixed to resemble approximately a Norfolk Sandy Loam. The mummies were divided into five equal parts, placed (1) on the surface of the ground, (2) half covered with soil, (3) entirely covered, (4) buried one inch, and (5) buried two inches, respectively.

B—Mummies suspended in the air in wire-mesh trays, to simulate mummies hanging on trees.

C—Temperature 30° C., in incubator. Mummies kept in water-tight, paraffined boxes, filled with the soil mixture used in A. Soil moisture variations maintained by dividing each lot between three boxes; in one the soil was kept dry, in the second moist, and in the third saturated. Depth variations as in A.

D—Temperature 9° to 11° C., in refrigerator, until November 24, 1920. After this, exposed to natural winter temperatures outside. An unheated shelter protected the

boxes from rain and snow. Soil moisture variations maintained as in C, and depth variations as in A.

E—Temperature, daily range of 10° to 25°, in greenhouse. Mummies transferred here were kept in boxes provided with holes for drainage, and were all kept in moist soil. Depth variations as in A.

EXPERIMENTAL METHODS

The general method employed was to place peach and plum mummies under different conditions, making observations at least once every five days throughout the duration of the experiment. Three variables were considered; temperature, soil moisture, and depth at which mummies were placed in the soil. Two series of experiments were run, the first with mummies obtained by inoculating fresh fruit, and the second with old peach mummies gathered from the orchard.

Series 1. The mummies used in this series were obtained by inoculating sound peaches and plums with brown-rot conidia from local peaches on July 22, 1920. About one bushel of Marianna plums and two bushels of peaches were inoculated and then kept for four weeks on a table in the laboratory at a temperature of 28° to 31° C. On August 20, the mummies were divided into twenty lots and placed under the conditions indicated in table 1.

Series 2. On March 11, 1921, large numbers of peach mummies from which apothecia had just started to grow were collected in the University orchards. The small, white, rudimentary apothecia were protruding 3 to 5 millimeters from the mummies. The mummies were kept overnight under a layer of moist soil, and then placed in watertight boxes well coated with paraffin and filled with a sandy soil. Seventy grams of mummies were placed at each of the following depths in the soil; (1) on surface, (2) half-covered with soil, (3) entirely covered, (4) buried one inch, (5) buried two inches, (6) buried four inches, and (7) buried eight inches. The soil was kept moist, but not saturated; and the boxes placed in the greenhouse at a daily temperature range of 10° to 22° C.

DEVELOPMENT OF APOTHECIA

On January 13, 1921, three apothecia were found growing from a plum mummy in lot 6, series 1. This mummy was one of those just covered by the soil. No other apothecia developed, in this first series, from any of the many other lots of mummies under artificial conditions. On March 14, 1921, about 25 small apothecia were found starting to develop on the bottoms of mummies under natural conditions (lot 13). By the nineteenth, 43 well-developed apothecia were present; and 78 were counted on March 23. Six days later these had practically all dried up, though on April 5 two apothecia were found.

These apothecia from mummies under natural conditions appeared coincident with the blooming period of stone fruits, which was ab-

normally early this year, the peaches being in full bloom about March 21. This correlation with the blooming period of stone fruits has been frequently mentioned by other writers.

Almost without exception, the apothecia in lot 13 were found growing on peach or plum mummies on the surface of the ground or half covered; only a few developed from mummies just under the surface of the ground. A single apothecium was found growing on a plum mummy buried one inch deep, but none developed from mummies buried deeper than this.

In series 2 (See Table 2) very definite results were obtained as to the depths at which apothecia will develop when sclerotia on which the rudiments of apothecia are visible are buried. Many apothecia

TABLE 2.

Results of experiment with brown-rot mummies, gathered in orchard March 11, 1921, after apothecia developed sufficiently to protrude from mummies.

DATE	NUMBER OF APOTHECIA PRESENT ON MUMMIES						
	ON SURFACE OF SOIL	HALF-COVERED WITH SOIL	ENTIRELY COVERED	BURIED 1 IN.	BURIED 2 IN.	BURIED 4 IN.	BURIED 8 IN.
Mar. 14	12	32	0	0	0	0	0
Mar. 16	12	47	0	0	0	0	0
Mar. 19	15	61	0	0	0	0	0
Mar. 23	19	55	0	0	0	0	0
Mar. 26	26	54	0	0	0	0	0
Mar. 29	3	10	0	0	0	0	0
Apr. 1	1	2	0	0	0	0	0

were produced from the mummies on the surface of the ground and from those that were half covered with soil, but none from any of the buried ones.

CONDITIONS AFFECTING THE PRODUCTION OF APOTHECIA

It is clear from the foregoing that the development of apothecia is inhibited by burying mummies in the soil. With the sandy soil used, the production of apothecia was prevented in all cases by burying mummies two inches deep. This agrees with the general belief that plowing mummies under will prevent the production of apothecia. That this practice will be effective even after the apothecia have started to grow is evident from the results obtained in series 2.

The effect of cold on the production of Sclerotinia apothecia was shown by the development of apothecia in lot 6, series 1. Here apothecia were produced in twenty-five weeks from the date of inoculation. Lot 6 had been chilled at 9°–11° C. for twelve weeks and exposed to outside winter temperature for two weeks, during which time the mean temperature was 5.8° C., and the minimum—2.7° C. It appears, then, that exposure to cold tends to hasten the production of apothecia.

SUMMARY

The production of apothecia from brown-rot mummies has been studied under different conditions. Under natural conditions apothecia may develop the spring following inoculation. Cold is probably a factor influencing the production of apothecia, as apothecia were produced in twenty-five weeks from chilled mummies. Burying mummies below the surface of the ground inhibits the production of apothecia, even if the development of apothecia has already commenced when the mummies are buried.

AGRICULTURAL EXPERIMENT STATION,
UNIVERSITY OF MARYLAND.

LITERATURE CITED

(1) ADERHOLD, R. Uber eine vermuthliche zu Monilia fructigena Pers. gehörige Sclerotinia. Ber. Deut. Bot. Ges. **22:** 262–266. 1904.

(2) ——— AND RUHLAND, W. Zur Kenntnis der Obstbaum-Sklerotinien. Arb. Biol. Abt. Land Forst. K. Gsndhtamt. **4:** 427–442. 1905.

(3) BROOKS, C. AND FISHER, D. F. Brown-rot of prunes and cherries in the Pacific Northwest. United States Dept. Agric. Bull. 368. *10 p.* 1916.

(4) DANDENO, J. B. Winter stage of Sclerotinia fructigena. Mich. Acad. Sci. Rpt. **10:** 51–53. 1908.

(5) NORTON, J. B. S. Sclerotinia fructigena. Sci. **16:** 34. 1902.

(6) ———————. Sclerotinia fructigena. Trans. Acad. Sci. St. Louis **12:** 91-97. *pl. 18-21.* 1902.

(7) POLLOCK, J. B. The longevity in the soil of the Sclerotinia causing the brown-rot of stone fruits. Mich. Acad. Sci. Rpt. **20:** 279–280. 1918.

(8) READE, J. M. Preliminary notes on some species of Sclerotinia. Ann. Mycol. **6:** 109–115. 1908.

(9) ROBERTS, J. W. The age of brown-rot mummies and the production of apothecia. Phytopath. **11:** 176–177. 1921.

(10) VALLEAU, W. D. Varietal resistance of plums to brown-rot. Journ. Agric. Res. **5:** 365–396. 1915.

ANTHRACNOSE OF THE GARDEN PEA.

FRED REUEL JONES AND R. E. VAUGHAN

WITH PLATE XXV AND TWO FIGURES IN THE TEXT

During a survey of the diseases of peas grown for canning purposes in Wisconsin, a single locality was found in 1912 where great damage had been done by anthracnoose caused by *Colletotrichum pisi* Pat. Although the fungus was isolated at this time and its pathogenicity proven, no published report was made. The disease was not seen again until 1920 when specimens were received from another locality in this state. Since in both instances the fungus caused even greater destruction in the area of its occurrence than is commonly caused by

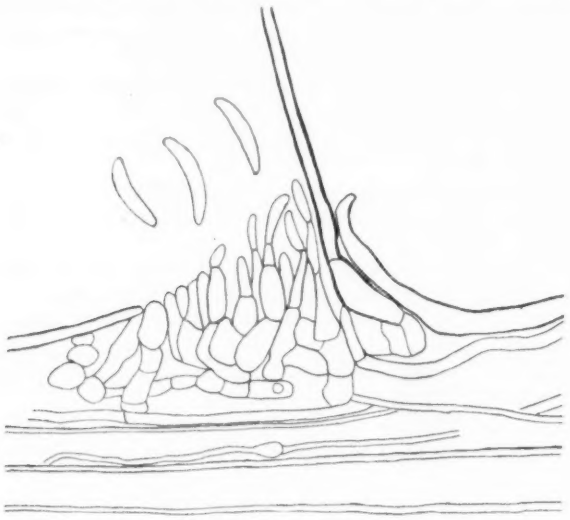


Fig. 1. Colletotrichum pisi Pat. on leaf of garden pea, showing relation of acervulus to the leaf tissue.

any of the well known parasites of peas, it was clear that an extension of its distribution might menace the pea growing industry. Therefore the fungus was again isolated in culture and a study of the disease made.

Colletotrichum pisi Pat. was first collected in Ecuador in 1891 by Lagerheim. A comparison of the fungus found in Wisconsin with the description given by Patouillard[1] reveals so many apparent differences

[1] Patouillard, N., and Lagerheim, G. de. Champignons de L'Equator. Bull. Soc. Mycol. France **7**: 158–184 (p. 180). 1891.

that the identity of the fungus was at first in doubt. The chief difference is in spore length, that given by Patouillard being only 11 to 13 microns, while spores from the material in hand range from 15 to 18 microns. However, an examination of a portion of Lagerheim's material in the Pathological Collections of the U. S. Department of Agriculture shows clearly that the measurements given in Patouillard's description are too small, and that there is no essential difference between the fungi (Fig. 1).

The only previous record that has been found of occurrence of this fungus in the United States consists of a collection under this designation on *Lathyrus odoratus* made by W. A. Orton at Macon, Ga., in 1907. The spores found in the acervuli on sweet pea leaves in this collection agree well in measurement with the description of the species to which they are referred, but they do not have the characteristic falcate shape. In view of the fact that infection of sweet peas has not been secured in spite of repeated inoculations, it appears that the fungi on the two hosts are at least physiologically distinct. The only report of the occurrence of this fungus since its description that the writers have found is that made recently by Hemmi[2] in Japan. Here the fungus is said to be widespread, though not often the cause of much damage. A detailed description of the fungus and of the disease is given.

The disease as it appears in the field is well described by Lagerheim as differing little in general character from that caused by the more common fungus, *Ascochyta pisi*. It occurs upon all aerial parts of the plant, and although it has not been detected upon the seed itself, there is no apparent obstacle to the penetration of seeds in diseased pods. Upon leaves, the lesions are irregular in shape, smoky gray or brown toward the margin, and lighter in color, usually tending toward a brown at the center (Pl. XXV). On pods, they are usually lighter in color, more nearly circular in shape, and dark brown at the margin. On stems, the lesions are elongate, rarely encircling the stem, and when covered with spores are ashen when dry and copper color when moist. Setae are sometimes produced so abundantly upon stems that they can be seen with a hand lens. On stems that are nearly mature, the fungus may produce in moist weather rusty areas of considerable extent where spores are produced in tiny acervuli.

The importance of the disease in the United States is, as already stated, probably slight owing to its apparently limited distribution. Unfortunately the localities in which it does occur have not been watched from year to year to determine whether the disease is usually so des-

[2] Hemmi, T. Nachträge zur Kenntnis der Gloeosporien. Jour. Col. Agr. Hokkaido Imp. Univ. **9**: (pt. 6) 309–311, pl. XIII. Aug., 1921.

tructive as during the two years mentioned. That the organism may find suitable conditions for production of destructive epidemics in some of the pea growing districts of the United States is not beyond possibility.

The host range of the fungus studied by inoculation of seedlings in the greenhouse includes, besides horticultural varieties of *Pisum sativum* L., *P. sativum umbellatum* (Mill.), *P. elatius* Bieb. and *P. jomardi* Schrank, through the two latter are not infected as abundantly as *P. sativum*. Attempts to secure infection of varieties of beans and of clover have not succeeded. The spores germinate abundantly on clover leaves, but in no case was the germ tube found to have penetrated the epidermal cell.

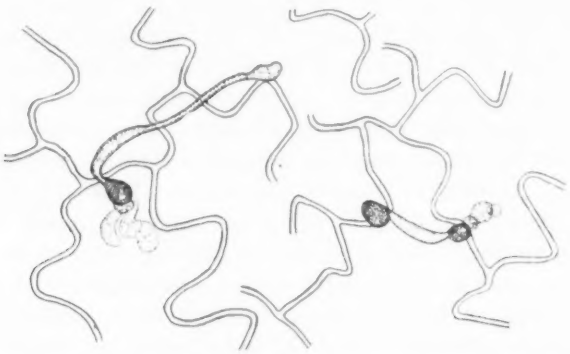
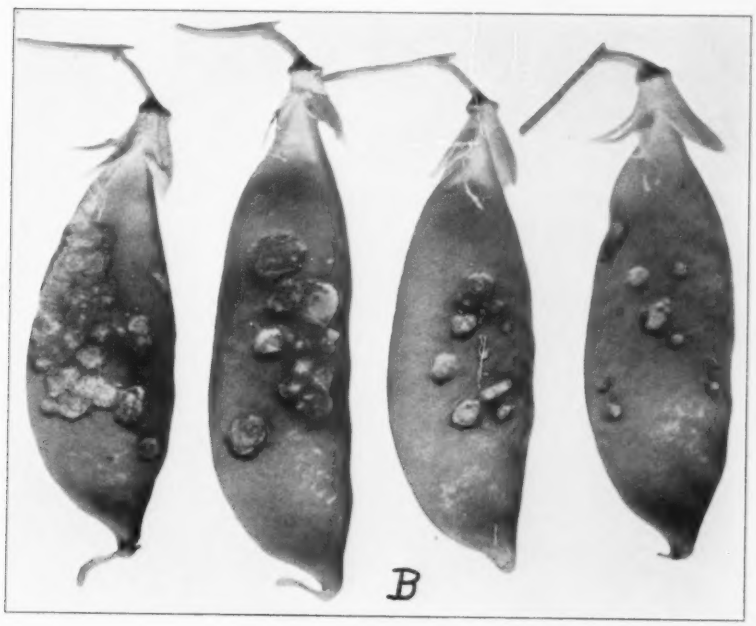


Fig. 2. Penetration of epidermal cells of a leaf of the garden pea by germinating spores of Colletotrichum pisi, showing appressoria on the leaf surface and mycelium within the cell 36 hours after inoculation at 21° C.

Cultures of the fungus have been obtained readily from spores which are usually very abundant upon stem lesions. It grows upon all common media, but upon most it does not fruit readily. The surfaces of the substrata become covered with black sclerotial bodies merging to form a crust upon which a few spores are sometimes found. Upon oatmeal agar that has become somewhat dried, a few deep yellow acervuli have been found near the advancing margin of growth. The most satisfactory substrate for spore production yet found is mature woody sweet clover or pea stems. New isolations transferred to these stems produce little aerial growth, while the fungus traverses the surface tissue of the stems upon which it produces in about a week an area of tiny convergent acervuli heaped with spore masses of a golden yellow or salmon color. Setae are produced sparingly. Very soon black sclerotial bodies appear at the point of inoculation, whence they spread



COLLETOTRICHUM PISI ON GARDEN PEAS

FIG. A. Lesions on leaf and stem of the garden pea. Photographed from plants inoculated in the field

FIG. B. Lesions on pods of garden pea. Photographed from plants inoculated in the greenhouse.

and replace the acervuli. Cultures which were kept upon artificial media for a year or even a shorter period of time produced spores less freely than recent isolations.

The conidia germinated readily upon agar plates to which no nutrient material was added at temperatures from 10° to 30° C. in 18 hours, the longer germ tubes being formed at temperatures between 20° and 30° C. In 24 hours spores germinated at temperatures down to 7° C. The method whereby the fungus enters the host is easily observed by decolorizing leaves at intervals after they have been sprayed with a spore suspension. At 21° C. spores germinated and produced appressoria on the leaf surface in 26 hours (Fig. 2). The germ tube produced at one, or often at each end of the spore is usually very short, the appressorium being formed very close to the end of the spore. After germination the spore sometimes appears to have a septum, but no true septum was demonstrated by staining. The appressorium is an irregularly rounded structure, conspicuous by its reddish brown color, and located more commonly near the edge of an epidermal cell. At the end of 36 hours at 21° C. the fungus was found to have penetrated the epidermal cell directly beneath the appressorium and to have begun to produce mycelium which was thick and rounded at first until the cell was partly filled with a stroma-like mass, after which mycelium began to radiate through the surrounding cells.

At present nothing is known regarding the method whereby the fungus survives the winter and becomes transported from place to place. Search will be continued for a possible ascogenous stage which has been suggested by the many small sclerotium-like bodies appearing in culture. It is not unlikely that seeds become infected and carry the fungus from place to place, though this has not been demonstrated.

SUMMARY

Anthracnose of the garden pea caused by *Colletotrichum pisi* Pat. has been found causing great damage to peas grown for canning purposes in two localities in Wisconsin in 1912 and 1920. At present the disease appears to be of limited distribution in America. The fungus infected readily all species of the genus Pisum that were tried, but no host outside of this genus was found. A brief description of the relation of the fungus to its host is given.

OFFICE OF COTTON, TRUCK AND FORAGE CROP DISEASE INVESTIGATION
WASHINGTON, D. C.
AND
UNIVERSITY OF WISCONSIN,
MADISON, WIS.

BRIEFER ARTICLES

PHYTOPHTHORA INFESTANS ON EGGPLANT IN THE UNITED STATES

R. J. Haskell

It will be recalled that during the growing season of 1915, conditions in the important late potato sections of the United States were particularly favorable for the development of *Phytophthora infestans*. The result was that late blight of potatoes occurred very widely, not only in the northeastern part of the country but also in the Great Lake States. The outbreak of that year has been recorded as one of the worst epiphytotics in the history of late blight in this country, ranking along with those of 1902–1905 in destructiveness.

During the summer of 1915 the writer was stationed in a field laboratory at East Fishkill, Dutchess County, New York. Among the plants being grown in the experimental garden, which occupied one corner of a thirty-two acre potato field, were six eggplants, all closely surrounded by potato vines. Early in August, Phytophthora began to appear on potato plants in the main field and by the end of that month all vines were badly affected. During the first week in September it was noticed that some of the fruit pedicels and calyces of the eggplants had blighted, and a few of the younger fruits, a number of which were still mere buds, were decaying. The lesions, which were confined mostly to the fleshy pedicels and calyces, were reddish-brown in color, somewhat sunken, and in most cases were covered more or less thickly with a white downy-mildew. When examined under the microscope this fungus appeared to be *Phytophthora infestans* and when microscopically compared with the fungus from potato the two were seen to be identical, at least with respect to the morphological characters. Measurements of the conidia showed them to be 23–35 x 15–23μ (av. 30 x 19μ), and when checked with the sizes of conidia of *P. infestans* from potato as reported by various other workers, it will be seen that they are in close agreement. Some of the measurements given for *P. infestans* are:

Schröter (4)	27–30 x 15–20 μ
Rosenbaum (3)	27.08 ± .145 x 18.27 ± .102 μ
Butler (1)	22–32 x 16–24 μ
Massee (2)	25–30 x 15–20 μ

As far as the writer is aware, this is the first report of the occurrence of *P. infestans* on the eggplant in this country but in Japan (5) the fungus has been recorded on this host (Kuroishi, Province Mutsu, 1913). In that country two different Phytophthoras occur on *Solanum melongena*, one *P. infestans* (Mont.) De Bary, chiefly on the calyces, and the other, *P. melongenae* K. Sawada, on the fruit (6). The conidia of the latter

organism are considerably larger than those of *P. infestans*, being 24–72 x 20–48μ (av. 42.4 x 33.9μ) so that there is little likelihood of confusing the two species when spore measurements are taken.

It is probable that *Phytophthora infestans* will never become a serious disease of eggplant in this country as this crop is southern in its range and for proper growth demands a climate which is not favorable to the late blight fungus. However, along the northern limits of its culture, and during late blight years, the disease may be expected to appear and possibly prove troublesome in certain restricted localities.

PLANT DISEASE SURVEY,
BUREAU OF PLANT INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE.

LITERATURE CITED

(1) BUTLER, E. J. Fungi and disease in plants. *547 p. 206 fig.* (*partly on col. pl.*) Calcutta, 1918. Bibliography, p. 518–531.
(2) MASSEE, GEORGE. Diseases of cultivated plants and trees. *602 p. 171 fig.* London, 1910.
(3) ROSENBAUM, J. Studies of the genus Phytophthora. Jour. Agric. Res. **8**: 233–276. *Pl. 71–77, 13 fig. 1917.* Literature cited, p. 273–276.
(4) SCHRÖTER, J. Peronosporineae. Engler, A. and K. Prantl. Die natürlichen Pflanzenfamilien, **1**[1]: 108–119. *Fig. 92–102.* 1897.
(5) SYDOW, VON H. AND P. Zweiter Beitrag zur Kenntnis der parasitischen Pilzflora des nördlichen Japans. Ann. Mycolog. **12**: 158–165. *1 fig.* 1914.
(6) TANAKA, TYOZABURO. New Japanese fungi—notes and translations II. Mycologia **9**: 249–253. 1917.

WOJNOWICIA GRAMINIS (McALP.) SACC. AND D. SACC. ON WHEAT IN THE UNITED STATES

H. H. McKINNEY AND A. G. JOHNSON

In connection with investigations on take-all and similar diseases of wheat conducted by the Office of Cereal Investigations, United States Department of Agriculture, in cooperation with the various States concerned, the writers visited a number of fields of diseased wheat in Dickinson County, Kansas, in June, 1921, in company with Professor L. E. Melchers, Plant Pathologist of the Kansas Agricultural Experiment Station. Owing to the fact that the disease in question showed the general field and plant symptoms attributed to the true take-all or foot-rot of Australia and Europe, a search was made for the perithecia of *Ophiobolus graminis* Sacc. and other organisms associated with the disease in foreign countries. While perithecia of *O. graminis* were not found, mature pycnidia of another fungus were found rather generally associated with the disease in a number of fields. Microscopic examination showed this fungus to agree in every respect with the descrip-

tion of *Wojnowicia graminis* (McAlp.) Sacc. and D. Sacc. (*Hendersonia graminis* McAlpine). This fungus was first described and illustrated by McAlpine from Australia (Take-all and white-heads in wheat. Jour. Dept. of Agr. Victoria, Australia, **2**: 410–425, 1904). McAlpine strongly suspected this form to be the pycnidial stage of *O. graminis* Sacc., the organism to which he and other workers attribute the cause of take-all or foot-rot. As far as known, *W. graminis* has not been previously reported in America.

Shortly after finding *W. graminis* on the Kansas material, both the pycnidia of this form and perithecia of *O. graminis* were found on dried wheat plants from Arkansas affected with take-all. The latter specimens were collected June 11, 1921, near Fayetteville, Arkansas, in company with Professors J. A. Elliott and H. R. Rosen, Plant Pathologists at the Arkansas Agricultural Experiment Station.

In July, 1921, the mature pycnidia of *W. graminis* were found by one of the writers (McKinney) on wheat plants which had been sent to the Plant Pathological laboratory of the Oregon Agricultural College, from LaGrande, Oregon. These plants showed a distinct mycelial plate and other symptoms attributed to the true take-all or foot-rot disease of wheat.

The pycnidia of *W. graminis* were found on the lower leaf sheaths both above and below the soil line. Usually they were found on the inner side of the sheath, later breaking through the sheath in the same manner as observed in the case of perithecia of *O. graminis*. With the naked eye or hand lens the pycnidia of *W. graminis* are apparently indistinguishable from the perithecia of *O. graminis*.

Preliminary studies have been made on artificial cultures of both forms. Cultures of *O. graminis* were obtained from three sources: 1, From Messrs. R. S. Kirby and H. E. Thomas, Department of Plant Pathology, Cornell University, Ithaca, N. Y., 2, from isolations from material collected near Corvallis, Oregon, by A. G. Johnson and Professors H. P. Barss and M. B. McKay of the Oregon Agricultural Experiment Station, and 3, from isolations made from the above mentioned material collected near Fayetteville, Arkansas. Cultures of *W. graminis* were obtained from spore isolations from the material, referred to above, collected in Kansas and Arkansas.

While it is not the present purpose primarily to consider the genetic connection between these two forms, as naturally this will require further study, it may be stated that the cultural characteristics of the two forms, *W. graminis* and *O. graminis*, on the same culture media, differ distinctly. This makes it seem rather doubtful if they are genetically connected.

INCIDENCE OF LOOSE-SMUT IN WHEAT VARIETIES

F. D. Fromme

During a wheat disease survey in Roanoke county, Virginia, in 1920, it was noted that all fields of the Leap variety (Leap Prolific) were practically free from loose-smut, *Ustilago tritici*.[1]

The amount of loose-smut found in any field of this variety did not exceed a trace, and often such affected heads as were seen were found to be of a bearded variety the seed of which had been mixed with that of the beardless Leap. In sharp contrast it was found that Stoner, a bearded variety which is grown extensively in the State, was generally and quite uniformly infected, the majority of the fields showing about 3 per cent affected heads. Later observations in other counties during the same season revealed the same condition with respect to the occurrence of loose-smut in fields of the two varieties in question, and such previous survey records as were available were also in agreement.

During the season of 1921 especial attention was given to the occurrence of loose-smut in fields of these varieties, and additional data were obtained. In all 52 fields of Leap have been inspected during the two seasons and not one has been found in which the amount of infection has been in excess of a trace. The fields were in 12 counties in practically all sections of the State. During the same seasons and in the same localities 74 fields of Stoner wheat were inspected. In three of these fields the infection did not exceed a trace, but in the remainder it varied from 1 to 10 per cent. These data are summarized in table 1.

TABLE 1

Incidence of loose-smut in Stoner and Leap varieties of wheat

VARIETY WHEAT	NO. FIELDS INSPECTED	PERCENTAGE OF LOOSE-SMUT					
		0-T	1-2	2-4	5-6	7-8	9-10
Stoner	74	3	34	18	13	4	2
Leap	52	52	..	..	..	..	..

* figures show number of fields found with the percentages as indicated.

The writer has shown previously[2] in a summary of the cereal disease survey data from several States that the percentage of loose-smut in fields of Leap in 1919 averaged 0.1 per cent while fields of Stoner averaged

[1] The first observations were made by R. C. Thomas of the department of Plant Pathology of the Virginia Polytechnic Institute and Nelson B. Rue of the Roanoke Chamber of Commerce.

[2] Plant Disease Bull. Suppl. **15**: 121. 1921.

3.6 per cent. It is impossible to state without experimental data whether the freedom from loose-smut shown in the Leap variety is a matter of resistance to infection or of disease escape. It is evident that the variety has been abundantly exposed to infection since it has been grown in the State for a number of years and the seed used is chiefly home grown. The mode of infection in loose-smut would suggest that a difference in the exposure of the stigma in the two varieties during blooming might readily account for differences in degree of infection. In a discussion of disease resistance in plants Appel[3] has stated that immunity to loose-smut in wheat and barley is due to the closed flowers found in the resistant varieties. To quote:—"As is generally known, there are wheat varieties which have closed flowers, which means that fertilization takes place within the glumes. In such cases the smut spores cannot reach the stigmas at the proper time, and therefore infection cannot take place." This is evidently a misstatement with respect to wheat, none of the varieties of which have closed flowers according to information available to the writer, but is no doubt true of barley in certain types of which (six-rowed, peacock, and two-rowed erect) the flowers do not open,[4] and the possibility of infection by wind-blown spores would seem to be excluded. That resistance in varieties of this type is a matter of disease escape has been demonstrated by Brefeld[5] who obtained abundant loose-smut infection in a cleistogamous variety of barley, in which the disease had never been observed, by the introduction of spores into the artificially opened blossoms.

The writer has made only a cursory comparison of the blooming of the two varieties of wheat under discussion and has not found any differences that appear to be significant; both have been seen to open during pollination. It is quite possible, however, that a thorough study of this point may reveal a difference in the duration of the exposure or some other feature in connection with blooming which will provide a mechanical basis for the relative immunity of the Leap variety.

It has occurred to the writer that comparative freedom from loose-smut may be associated with the beardless habit, and such data as is available indicates that bearded varieties are more susceptible as a group than the beardless varieties. Table 2 shows occurrence of loose-smut in varietal tests at Blacksburg in 1921, the varieties being grouped in the table according to presence of beard. Most of these varieties have been grown

[3] Appel, Otto. Disease resistance in plants. Science n. s. **41**: 778. 1915.

[4] Robbins, W. W. The botany of crop plants, p. 139. 1917.

[5] Brefeld, O. Investigations in the general field of mycology. English translation by Frances Dorrance, part 13, p. 29. 1912.

in close association for a number of years and the exposure to infection should be about the same. It will be noted that the amount of loose-smut shown by the bearded varieties is as a rule considerably in excess of that shown by the beardless ones, and that with the exception of a few

TABLE 2

Incidence of loose-smut in bearded and beardless varieties of wheat in varietal test plots at Blacksburg, Va., June 3, 1921. Figures are number of affected heads in two 66-foot rows

BEARDED VARIETIES		BEARDLESS VARIETIES.	
Hopper	36	Rice	18
Stoner	28	Blue Straw Fultz	17
Bearded Purple Straw	25	Purple Straw	9
Red Wonder	22	Perfection	6
Lancaster	21	Currell Prolific	6
Mediterraneap	15	Red Wave	4
Dietz Amber	13	Jones St. Louis Prize	3
Turkey Red	13	Early Ripe	3
Diamond	12	China	3
Ironclad	12	Rural New Yorker No. 6	2
Nigger	11	Jones Climax	1
Egyptian	10	Red May	1
Rudy	10	Gold Coin	0
Fulcaster	8	Harvest King	0
Red Rock	7	Fultz	0
Blue Ridge	5	Leap	0
Auburn	4		
Davidson	1		
Kanred	1		
Golden Wave	0		

TABLE 3

Percentage of loose-smut in varietal test plots at three sub-stations. The counts at Appomattox by H. L. Lewis in 1918, at Staunton by G. M. Reed and F. D. Fromme in 1920, and those at Chatham by D. J. Burger in 1921

VARIETY	TYPE	APPOMATTOX	STAUNTON	CHATHAM
Stoner	bearded	3	4	5
Red Wonder	do.	2	4	4
Fulcaster	do.	2	3	4
Harvest King	beardless	0	t	..
Fultz	do.	0	t	0
Leap	do.	0	t	0

varieties the beardless group is but slightly affected. The average amount of loose-smut in the bearded group is about three times that found in the beardless group, 12.7 against 4.6 per row affected heads. Table 3 shows percentages of loose smut in certain varieties in varietal test plots at three of the sub-stations of the Virginia Agricultural Ex-

periment Station. The data which are for three separate years are in close agreement, the three bearded varieties, Stoner, Red Wonder and Fulcaster, showing quite uniform infection greatly in excess of that shown by the three beardless varieties, Harvest King, Fultz and Leap, which are almost entirely smut-free.

It seems evident that wheat varieties exhibit differences in susceptibility to loose-smut and it appears that control of the disease may be realized by choice of varieties, and possibly also through breeding or selection. Although questions of greater importance enter into the choice of wheat varieties, susceptibility to loose-smut may well be considered in connection with varietal improvement studies, especially in the South Atlantic States.

VIRGINIA POLYTECHNIC INSTITUTE
BLACKSBURG, VIRGINIA.

CONVENIENT CHAMBERS FOR INOCULATION OF PLANTS WHERE HIGH HUMIDITY AND MODERATE TEMPERATURES ARE REQUIRED

A. F. CAMP

In making artificial inoculations during a recent investigation of citrus blast[1] at Berkeley, California, it was found necessary to simulate, as far as possible, the winter conditions in the upper Sacramento Valley, where the disease is endemic. Citrus blast appears in this locality only during the rainy periods of January and February and is consequently accompanied by a fairly low temperature and very high humidity amounting at times to almost continual light or misty rain for considerable periods. Cages similar to those described by N. Rex Hunt[2] but about three feet tall, were first built, it being necessary to have them large enough to cover a small orange tree. These cages, however, were too high to be operated by this method. The cloth was saturated for only a short distance before the level in the pans became so low that the water would not rise over the rim fast enough to replace the water evaporated, and the cloth would consequently gradually dry out. This could be partially remedied by keeping the pans on top of the cages constantly at the point of overflowing, by means of a small stream of water. This design was subject to two serious difficulties, 1, the pan on top of the cage must be perfectly level, 2, the stream of water must be accurately adjusted or a ball float used. It was fairly satisfactory, however, in that it provided a very cool atmosphere almost saturated with water vapor due to the evaporation from the cloth.

[1] Fawcett, H. S., Horne, W. T., and Camp, A. F. Citrus blast and black pit. The California Citrograph, **6**: 234. May, 1921.

[2] Hunt, N. Rex. The "iceless refrigerator" as an inoculation chamber. Phytopath. **9**: 211–212. 1919.

This type of chamber did not prove entirely satisfactory for work with citrus blast because there was insufficient moisture actually present on the leaves. In order to meet this difficulty another form of cage was devised. One large and one small one, to be used as space demanded, were built. In these, Vermorel nozzles, manufactured by the Bean Spray Company, were used to produce a spray or mist. The large apparatus was ten feet high with a floor space 11 x 6 ft. and covered with heavy muslin, the floor was tightly boarded and covered with a heavy roofing paper well cemented and sloped slightly to one corner where there was a drain, and was provided with sides two or three inches high to keep the water from running off the edges. In putting in the flooring the roofing paper was cut and laid without cementing for some time, to prevent its wrinkling on service. To prevent breaking where the roofing paper was cupped up at the sides, it was supported by a two by four ripped diagonally and laid with the long side down.

TABLE 1.

Temperatures (F.) in the moisture cage at Berkeley.

DATE	IN CAGE		OUTSIDE		WEATHER
	MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	REMARKS
10/8	62	52	68	48	
10/9	60	54	67	52	Rainy
10/10	61	56	61	53	Cloudy
10/11	62	56	70	52	Light clouds
10/12	62	56	66	51	Sunshine
10/13	62	50	*84	46	Sunny
10/14	60	52	*86	48	Sunny
10/15	64	52	*84	52	Sunny
10/16	62	52	64	46	Sunny
10/17	58	53	59	51	Cloudy
10/18	58	54	59	51	Cloudy
10/19	57.5	52	58	46	Sunny
10/20	58	50	58	42	Sunny
10/21	59	51	62	44	Light clouds
10/22	58	53	58	48	Foggy
10/23	60	53	62	49	Sunny
10/24	62	54	72	53	Sunny
10/25	62	54	69	50	Sunny
10/26	62	52	66	46	Sunny
10/27	61	54	62	50	Cloudy
10/28	61	55	59	50	Cloudy
10/29	64	53	63	49	Sunny, water off part time
10/30	61	50	66	54	Sunny
11/1	55	50	60	42	Sunny

* Too high, sun on instrument.

The muslin was put on with considerable slack to make up for the shrinkage and was lapped generously. The muslin was boiled before use so that it would take water freely. In order to keep the cloth on the top quite taut and to avoid an annoying drip, one side was made about a foot higher than the other. A pipe line was carried in about three and one-half feet above the floor and a two hole Vermorel nozzle attached to the end with an elbow so as to shoot upward.

With this apparatus and with sufficient pressure on the pipe line, a very fine mist was obtained which did not tend to wash the foliage sufficiently to carry away the inoculum. The pressure used at Berkeley was probably not in excess of fifteen pounds, but with more pressure a finer mist would result. The sides and roof wet by the spray kept the temperature well down, as shown in the accompanying table. The height from the floor to the roof was found to be necessary to avoid dripping and to make the spray fine enough.

Where an absence of drip due to the spray actually coming in contact with the leaves is desirable, it was found feasible to hang a frame work or roof about six feet by three feet under the nozzles, leaving a space between it and the wall all the way around. The plants when placed under this roof were in a saturated atmosphere and yet were not wet directly by the spray. This roof may be covered with roofing paper or with a fabric similar to oiled silk so that the light may pass through. For individual covers for plants large panes of glass answered very well.

In order to work where space was restricted, a small cage was made to set in a four foot square metal pan. The cage was about three and one-half feet high with a single Vermorel nozzle pointing downward thru the top. About six inches below the nozzle a glass plate about six inches square was suspended. The cone of water from the nozzle which had a very small opening, struck this plate and was thoroughly broken up. The sides were kept wet easily and the only annoyance was the drip from the glass plate. For a few small plants it is easy to substitute a pane of window glass for the small glass plate, the plants being placed under this shelter which is tilted just enough to prevent any drip on the under side.

PHYTOPATHOLOGICAL NOTES

Phoma insidiosa on sorghum. In the paper "Phoma on Sweet Sorghum,"[1] the writers tentatively gave the fungus the name *Phoma insidiosa* F. Tassi, until a type specimen of the African fungus could be examined. Through the courtesy of the International Institute of Agriculture in Rome and Dr. F. Tassi of the University of Siena, four of the type specimens of durra sorghum seed have been received. In spite of its age the seed was in perfect preservation and the pycnidium selected for microscopic examination contained abundant conidia. The fungus growing on the Abyssinian seed is similar in appearance, size of pycnidia and conidia, to that found on the sweet sorghum seed raised in Arkansas and is believed to be the same organism. Some of the conidia were measured with the apparatus used in measuring the American specimens. The mean of these measurements of Dr. Tassi's specimen, 6.6 x 3.6μ, is larger than his published measurement, which is 6 x 2–2½μ, but it corresponds to those of the conidia taken from the seed coat of the sweet sorghum, Planters' Friend. This difference in measurements can easily be attributed to the difference in methods of measuring. Dr. Tassi described the fungus as producing ash colored or white spots on the epidermis of the seeds. It happened that the American sweet sorghum seed which was examined did not show these spots. However, it was found that the spots could be produced when the fungus was cultivated on sorghum seedlings in the laboratory. If the atmosphere was very humid, a group of rapidly growing pycnidia would raise and rip off the upper epidermis for some distance before breaking through it. After this loosened skin dried it assumed an ashy or silvery hue. On one of Dr. Tassi's seed, pycnidia were found protruding without having produced a discolored spot on the epidermis.

The records of the Federal Horticultural Board showed that in 1908, some sorghum seed was imported from Vereeniging, Transvaal, South Africa, which was infested with *P. insidiosa*. In 1914, out of 18 varieties of sorghum imported from Nyembe, Bulungwa, East Africa, 13 varieties had Phoma infected seed.

As *Phoma insidiosa* appeared to infect sweet and grain sorghum equally readily, an attempt was made to find the general geographic distribution of the fungus. Through the courtesy of Dr. H. Vinal of the Office of Forage Crop Investigations, his collection of foreign sor-

[1] Koch, Elizabeth, and Caroline Rumbold. Phoma on Sweet Sorghum. Phytopath. **11**: 253-268. 1921.

ghum seed was examined. The list of the varieties of seed found infected with Phoma shows that the fungus is rather wide-spread throughout the sorghum growing countries. The names of the varieties of sorghum are given when they are known, but as the African varieties did not have definite names they are indicated by the number given them by the Forage Office so that an idea can be obtained of the number of varieties which had infected seed as well as the district in which they grew.

CHINA.

White kai liang. Honan.

INDIA.

Pyaung-shwe-wa. Burmese dry zone. Meiktile.
Dodania. Cawnpore, United Provinces.
Andhri. Cawnpore, United Provinces.
Patcha Jonna. Bellary. Madras.
Palpu Jonna. Madras.
Peria Manjal Cholani. Madras.
Nilwa. Poona, Deccan.
Hundi. Poona, Deccan.
Dukuri. Poona, Deccan.

AFRICA.

No. 1463. Rejaf, Mongalla Province, Ango-Egyptian Sudan.
No. 1467a. Rejaf, Mongalla Province.
No. 1331. Rejaf, Mongalla Province.
No. 1324. Rejaf, Mongalla Province.
No. 1266. Misindi, Northern Province, Uganda.
No. 1301. Panymur, Northern Province, Uganda.
No. 935. Zanzibar, Zanzibar.
No. 916. Kizoma, Zanzibar.
No. 653. Ujiji, Zanzibar.
No. 243. Bulawayo, Victoria Falls, Rhodesia.
No. 130. Basuto land, Pretoria, Transvaal.
Kafir corn, Johannesburg, Transvaal.
No. 115. Taungs, Transvaal.
Kafir corn of the district Vereeniging, Transvaal.

DUTCH WEST INDIES.

Maiz chikitoe hasen harina. Curacao.
Mais chiquito. Willemstad, Curacao.

Dr. Tassi's type specimens, the collection of infested foreign sorghum seed and some of the American seed have been deposited in the herbarium of the Office of Pathological Collections, Bureau of Plant Industry.—CAROLINE RUMBOLD AND ELIZABETH KOCH TISDALE.

Head smut of corn in Washington. An inspection was made of sixty different corn fields located in central and southern Whitman County, Washington, during the months of August and September 1921 in an effort to determine the prevalence of head smut of corn (*Sphacelotheca reiliana* (Kühn) Clinton). The disease was found for the first time in this state in two corn fields near Pullman in 1919, and was later reported in popular bulletin 119 of the Washington Agricultural Experiment Station. Inspections were begun in the field where the disease was first discovered. The owner of that farm informed the writer that his 1920 crop of corn was so badly diseased that he had given up the idea of growing corn and had planted his fields to alfalfa. Six different fields quite widely separated from each other, showed limited quantities of head smut in three and an abundance in three others. In one field the head smut was found affecting both *Zea mays indentata* and *Z. mays saccharata*. During the present season (1921) this corn smut has also been reported from the Yakima Valley and found to be quite serious on corn in that section. The disease is not known to occur on sorghum in Washington. Sorghum, however, is not extensively grown in the sections where head smut is found.—CHAS. S. PARKER.

"Black point" of wheat.—Observations during the past year have shown that a comparatively high percentage of the kernels of the durum wheats of the Upper Mississippi Valley are often partly or entirely discolored, especially at the embryo end. These areas are dark brown or creosote colored. Hundreds of isolations made from typically discolored kernels have given, in the majority of cases, a species of Helminthosporium similar to *Helminthosporium sativum* P. K. and B. For example, in one series of black pointed seeds (260 kernels of D5 and Acme) 77.6 per cent. of the kernels yielded this fungus, while platings from several series of apparently healthy, plump seed from the same samples gave none of this organism. Likewise, the bran layer from discolored areas, when plated, gave from 85 to 100 per cent Helminthosporium. Discolored seeds when placed in moist chambers gave uniformly a surface sporulation of this same organism. In July 1921, a number of inoculations were made in the field at Madison, Wis. Water suspensions of conidia of the fungus were applied to the heads of Acme and D5 wheat when in flower. Heads thus inoculated were covered with glassine bags for one and two days. In the cases where the inoculations were made when the conditions for infection were most favorable, abundant "black pointed" kernels resulted, in contrast to a low percentage in the controls where only water was applied.—NEVADA S. EVANS.

Phytopathological Society in the Philippines.— At a meeting held at the Bureau of Science, Manila, on August 6, 1921, the plant pathologists and other botanists interested organized the Philippine Phytopathological Society Twenty-two persons indicated their interest in the organization and they constitute the charter members of the society. The purpose of the organization is stated in the preliminary announcement of the society:

"It seems desirable for a number of reasons to have a rather informal organization of plant pathologists in the Philippines. The most cogent reason for the information of such a society is to avoid, as much as possible, duplication of effort; although such duplication sometimes has its advantages, in a field where so much new work is urgent as in this country, any two men doing the same work is an extravagance at the present time.

"It is far from the intention that this society shall draw rigid lines of demarcation for the work of each investigator; yet before such a society each individual may talk over his work and outline for future work, and a proper spirit of understanding and cooperation by his associates will cause them to aid the individual in his problems. Such a society will be moreover an aid to good fellowship and a stimulus to research."

The following officers were elected: President, Dean Chas. F. Baker; Vice-President, Colin G. Welles; Secretary, H. Atherton Lee; Treasurer, Gonzalo Merino. A committee was appointed to draw up a constitution and it was agreed that meetings are to be held bimonthly. The matter of applying for affiliation with the American Phytopathological Society is under consideration.—H. ATHERTON LEE AND COLIN G. WELLES.

Personal. Mr. W. K. Makemson, formerly Food Products Inspector at Cleveland Office of the Bureau of Markets, has accepted the position of Extension Entomologist and Plant Pathologist in the Florida College of Agriculture.

Mr. J. H. Muncie, formerly Assistant in Plant Pathology at the Michigan Agricultural Experiment Station and more recently Assistant Professor of Plant Pathology at Pennsylvania State College, has accepted an appointment as Assistant Plant Pathologist of the Iowa Agricultural Experiment Station.

Dr. H. W. Dye has resigned as Ass't Professor of Plant Pathology at Cornell University to accept a position as Pathologist in the Research and Development Department of the Dosch Chemical Company, Inc., Louisville, Kentucky.

The November number of Phytopathology was issued February 25, 1922.

INDEX TO VOLUME XI

New species in blackfaced type.

Abies, balsamea, Polyporus picipes on wood of, 323; concolor, Fomes applanatus on wood of, 324; concolor, Fomes pinicola on, 326; concolor, Polystictus versicolor on wood of, 321; concolor, Schizophyllum commune on wood of, 320; concolor, Stereum hirsutum on wood of, 320; grandis, host of Polyporus dryadeus 99, 323; grandis, Thelephora terrestris on seedlings of, 142

Abstracts of papers presented at the, twelfth annual meeting of the American Phytopathological Society, Chicago, December 28 to 31, 1920, 31–60; fourth annual meeting of the Pacific Division, Seattle, June 17–18, 1920, 103–106; second annual meeting Canadian Division, Guelph, Ontario, December 9 to 10, 1920, 202–204

Acacia, sp., host of Fomes applanatus, 326; sp., Schizophyllum commune on, 325; melanoxylon, Schizophyllum commune on, 325.

Acer, sp., host of Cytospora chrysosperma, 157; macrophyllum, Thelephora terrestris on, 142; negundo, Thelephora terrestris on, 142; platanoides, Schizophyllum commune on, 325; rubrum Schizophyllum commune on, 325;, saccharum, Schizophyllum commune on 325; saccharinum, host of Polyporus gilvus, 325

Acid phosphate, effect on control of tomato leaf-spot, 433–445

Acids, tolerance of bacteria to, 244–250

Actinomyces scabies, 6–9, 13–17

Adams, J. F. Observations on wheat scab in Pennsylvania and its pathological histology, 115–124

Adenostegia sp., host of Peridermium filamentosum, 45; host of Peridermium harknessii, 45; host of Peridermium stalactiforme, 45

Aecia, of Puccinia albiperidia borne internally, 343–344

Aesculus californica, Polystictus hirsutus on wood of, 321

Agropyron repens, host of Claviceps sp., 42

Airplane timber, decay of, 45

Air temperature, relation to plant diseases, 446–458

Alfalfa, dry rot of roots of, by Fusarium, 383

Allium cepa var. bulbellifera, host of Botrytis sp., 87–90; host of Puccinia asparagi 87–90

Almond, host of Cyphella marginata, 105

Alnus incana, host of Lenzites saepiaria, 324

Alternaria, sp., on wheat grains, 37; brassicae nigrescens on cantaloupe, 137; **nelumbii** n. sp., on Nelumbium speciosum, 135–140; solani, on tomatoes, 379–380

Amaranthus retroflexus, host of cucurbit mosaic, 47

Amelanchier cusickii, host of **Sclerotinia gregaria**, 106, 225–226

American Phytopathological Society, abstracts, twelfth annual meeting of, 31–60; abstracts, second annual meeting of Canadian Division of, 202–204; report twelfth annual meeting of, 194–201; notice of summer meeting of, 376; fourth annual meeting of Pacific Division of, 103–106

Ammonia, use in seed treatment, 470–471

Anaerobic bacteria in plant tissues, 344

Angular leaf-spot, of cucumber, 297–299

Anthracnose, of cucumber, 298–299; of mango, 26; of garden pea, 500–503

Aphids, carriers of sugar beet mosaic, 349–365

Aplanobacter stewarti on corn, 31

Apothecia, of Cenangium abietis, 166–169; of Sclerotinia cinerea, 176–177; factors affecting production of Sclerotinia cinerea, 495–499

Apparatus; constant humidity case, 51; inoculation platforms, 81; celluloid cone damp chambers, 81–82; Petri dish inoculations, 82–84; chisel-forceps, 175; cone and cup cultures, 239–241; to regulate air temperature and humidity, 446–458

Apple, bitter pit of, 366–370; collar rot of, 105; Cytospora canker of, 105; moldy core of, 105; root rot by Thelephora galactina, 141; Valsa canker of, 236–243; European canker of, on Pacific slope, 464–468

Armillaria, sp.. cultures of, 154; mellea, on Thuja plicata, 176; mellea on Lupinus arboreus, 391–392

Arrhenatherum elatius, host of Claviceps sp., 42

Asclepias syriaca, host of cucurbit mosaic, 47

Ascochyta, rubi, 328; ruborum, 328

Aspen, see Populus tremuloides

Aspergillus sp., 13

ATWOOD, W. M., Physiological studies of the effects of formaldehyde on wheat, 103

Bacillus, apivorus on celery, 55; atrosepticus on potato, 104; carotovorus, 55; coli, 248; melanogenus on potato, 104; phytophthorus on potato, 104, solanisaprus on potato, 104, tracheiphilus on cucumber, 299–300; typhosus, 248; solanacearum, relation of air temperature to, 446–458

Bacteria, sp., causing witches'-brooms of Pinus maritima, 27; on lima bean, 52; on tomato, 55, tolerance to acids in media, 244–250; anaerobic, in plant tissues, 344

Bacterial, blight, of bean, 61–69; blight, of pea, 104; rot of corn, 74–79; spot of tomato 55

Bacteriosis, of celery, 55

Bacterium, angulatum, tolerance to acid, 244–250; campestre, tolerance to acids, 244–250; carotovorus, tolerance to acids 244–250; glycineum, on soybean, 18–24; glycineum, tolerance to acids, 244–250; lacrymans, on cucumber, 298; phaseoli, on bean, 61–69; sojae, on soybean, 18–24, 52; sojae, tolerance to acids, 244–250; tabacum, tolerance to acids, 244–250; tabacum, relation of air temperatures to, 455–456

BAILEY, D. L., see FRASER, W. P.

Barberry, eradication of, 4; host of Puccinia graminis, 39–40

Barium water Bordeaux, 184, 192

Barley, resistance to Helminthosporium sativum, 405–411

BEACH, W. S., A Phytophthora crown rot of rhubarb, 55–56

Bean, bacterial blight of, 61-69

Beech, see Fagus sp.

BENNETT, C. W., see YOUNG, H. C.

BETHEL, ELLSWORTH, Notes on the Peridermiums of pines in Colorado and California, 45; and POSEY, GILBERT B. Investigations to determine the identity of a Cronartium on Ribes in California, 46; Report on pinon blister rust in California (title), 105

Bibliographie der Pflanzenschutzliteratur, 377

Biography and portrait of Dr. F. Kölpin Ravn made available, 101–102

BISBY, G. R., Sclerotinia disease of sunflower in Manitoba, 49; The cooperative potato spraying project (committee report), 60; The cooperative potato spraying project: progress report for 1918 1919, and 1920, 178–193

Bitter pit, of apples and pears, 366–370

Black, leafspeck of cabbage, 44; point of wheat, 515; rot of cabbage, 53–54; spot of rose, 128

Blight, bacterial, of bean, 61–69; of corn seedlings, 35–36; bacterial, of pea, 104; of peach blossoms, 290–294; of pear by Botrytis, 105; late, of potato, 94–96

Blister rust, of pinon, 105

BLODGETT, F. M., and FERNOW, KARL Testing seed potatoes for mosaic and leafroll, 58–59

Blossom blight of peach, 43, 290–294

Blue stone, injury to wheat seed, 103

Bordeaux, dust, 184; mixture, 60, 178–193

Botrytis sp., on Allium cepa, 87–90; causing pear blight, 105

Box elder, host of Septoria negundinis, 100
Break-down of tissues, 44
Bremia lactucae, on Lactuca spp., 54
BRIGGS, FRED N., see MACKIE, W. W.
Bromus, inermis, host of Rhyncosporium secalis, 42; mollis, 385
Brown rot, fungus, apothecia of, 176–177; fungus, age of mummies of, 176–177; of peach, 43
BULLER, A. H. R., Upon the ocellus function of the subsporangial swelling of Pilobolus (title), 204; Upon the chemotactic attraction of fungi for slugs (title), 203; The sound made by fungus guns and a simple method for rendering audible the puffing of Discomycetes (title), 203
Bunt, effect of treatment for, on germination of wheat, 469–484
Bur clover, Cercospora leaf spot of, 311–318
Burgundy mixture, 182
BURKHOLDER, WALTER H., The bacterial blight of the bean: a systemic disease, 61–69
BURNS, G. P., Tip-burn and the leafhopper, 56–57
BUTLER, E. J. The Imperial (British) Bureau of Mycology, 100
BYARS, L. P., Notes on the citrus-root nematode, Tylenchulus semipenetrans Cobb, 90–94

Cabbage, black leaf-speck of, 44; black rot of, 53–54; lightning injury of, 97–98; resistance to yellows, 54
CAESAR, L., Practical hints for the young plant pathologist, 203–204
Callistephus chinensis, host of Septoria callistephi, 50
CAMP, A. F., Convenient chambers for inoculation of plants where high humidity and moderate temperatures are required, 510–512
Canada thistle, host of sunflower Sclerotinia, 49
Canker, of apple, 236–243; of citrus, 70–73, 109–114a; of citrus, in Hawaiian Islands, 377; of poplar, 157–165; European, on Pacific Slope, 464–468
Capsicum annuum, host of cucurbit mosaic, 47
Castilleja sp., host of Peridermium filamentosum, 45; host of P. harknessii 45; host of P. stalactiforme, 45
Ceanothus thyrsiflorus, Schizophyllum commune on, 325
Cedrela sinensis, Schizophyllum commune on, 325
Cenangium abietis on Pinus ponderosa, 166–170; piniphilum on Pinus ponderosa and P. contorta, 294–296
Ceratostomella spp. on wood of white pine, scrub pine, western white pine, western yellow pine, shortleaf pine, loblolly pine, red gum, persimmon, aspen, and northern white cedar, 214–224; coerulea, 217; pilifera, 216, 219, 222, 295, pini, 217
Cercospora medicaginis on bur clover, 311–318
Cereal pathologists, summer meeting of, 177
Celery, bacteriosis of, 55; yellows of, 54–55
Celluloid cones as damp chambers, 81–82
Chlamydospores, of Fomes officinalis, 173–175
Chambers, inoculation, 510–512
Chemotaxy, of fungi for snails, 203
Choke cherry, host of Sclerotinia demissa, 106
Chrysomyxa, abietis, 388
CHURCH, MARGARET B., The relation of mosaic disease to pickling of cucumbers, 28–29; The relation of mosaic disease of cucumbers to pickling, 47
Citrus, aurantifolia, host of canker, 70–73, 112; aurantium subsp. intermedia var. natsu daidai, host of canker, 70–73; blast, inoculation chambers for, 510–512; canker, 70–73; canker in Hawaii, 377; chlorosis, relation to soil conditions, 301–305; fruit spots caused by tissue breakdown, 44; limonia, host of canker, 70–73; maxima, host of canker, 70–73; mitis, host of canker,

70–73; nobilis, host of canker, 70–73; nobilis, resistance to canker, 109–114a; nobilis var. deliciosa, host of canker, 109–114a; nobilis var. deliciosa, host of Tylenchulus semipenetrans, 90–93; root nematode, 90–93; sinensis, host of canker, 70–73; trifoliata, host of canker, 70–73

Cladosporium, spp., in cores of apples, 105; fulvum, on tomato, 232

Clavaria stricta, 143

Claviceps, sp., on Arrhenatherum elatius, 42; on Agropyron repens, 42; on Bromus inermis, 42; on Poa pratensis, 42; on rye, 41–42; on wheat, 42; purpurea, on rye, loss from, 41, 285–289

Colecsporium, campanulae, 388; compositarum, 388; ribicola, new hosts for 45; solidaginis, new hosts for, 45

Colletotrichum lagenarium, on cucumber, 298; pisi on Pisum elatius, jomardi and sativum, 500–503

COLLEY, REGINALD H., The effect of incipient decay on the mechanical properties of airplane timber, 45

Collybia velutipes, on Lupinus arboreus, 389–404; on Lupinus chamissonis, 394

Conifer seedlings, methods of inoculating, 80–84

Control, of potato scab, 6–17, 150–151; of root, stalk, and ear rots of corn, 33–35; of wheat bunt, 37–39; of cereal nematodes, 41; of rice straighthead, 42–43; of peach blossom blight, 43; of apple scab, 43–44; of cucurbit mosaic, 47; of sugar beet mosaic, 48; of tobacco wildfire and angular spot, 48–49; of downy mildew of lettuce, 54; of bacterial spot of tomato, 55; of potato wart, 57; of rose mildew, 128; of rose black spot, 128; of stem girdle of spruce transplants caused by excessive heat, 485–490; of tomato leafspot affected by fertilizers and lime, 433–445

Convenient chambers for inoculation of plants where high humidity and moderate temperatures are required, 510–512

COOK, MEL T., Blossom blight of the peach, 43; The blossom blight of the peach, 290–294; Falling foliage, 337–339; Wilting caused by walnut trees, 346; Sunburn and tomato fruit rots, 379–380

COOLEY, J. S., Disinfecting laboratory cutting instruments, 378

COONS, G. H., and NELSON, RAY, Celery yellows, 54–55

Copper, carbonate dust for bunt, 39; dust for potato blight, 180, 185, 193; dust, Sander's for tomato leaf-spot, 229, 233–235; soap dust for tomato leaf-spot, 229–235; soap liquid for tomato leaf-spot, 230–235; sulphate for bunt, 37–38, 469–484; sulphate for Rhizoctonia solani, 59–60; sulphate in soil, effect on control of tomato leaf-spot, 433–445; sulphate in water of soil, effect on Puccinia malvacearum, 460–462

Corn, bacterial rot of, 32–33, 74–79; decayed by Rhizopus nigricans, 279; ear rot of, 33–34; Fusarium wilt of, 33; Philippine mildew of, 32; root rot of, 32–35; rots of, 33; rust of, 31–32; seedling blight, 35–36; smut of, 32; stalk-rot of, 32–34; Stewart's disease of, 31

Cornus masculus, host of Rhizopus nigricans, 279

Corrosive sublimate, for Rhizoctonia, 150–151; for seed treatment, 470

Corticium, sp., cultures of, 154; vagum, on sugar beet, 48; vagum, temperature influencing pathogenicity of, 56

COTTAM, WALTER P., A "dry rot" disease of alfalfa roots caused by a Fusarium, 383

Cotton, Phoma disease of, 48

Crataegus sp., host of Fomes applanatus, 326

CRAWFORD, R. F., Overwintering of mosaic on species of Physalis, 47

Crocus sativus, host of Rhizoctonia crocorum, 413

Cronartium, sp., on Castilleja, 45; sp., on Quercus, 45; sp., on Ribes, 45; sp., overwintiring of, 45; occidentale, on Pinus monophylla, 46; occidentale, on

Ribes, 46; ribicola, 388; ribicola, investigations of, 170–172
Crown-canker of rose 125–134
Cucumber, angular leaf-spot of, 297-299 anthracnose of, 298–299; bacterial blight, overwintering of, 299–300; host of Colletotrichum lagenarium, 298; mosaic of, 28–29, 46–47; mosaic, transmitted to Asclepias syriaca, 47; mosaic, transmitted to Capsicum annuum, 47; mosaic, transmitted to Martynia louisiana, 47; mosaic transmitted to Micrampelis lobata, 47
Cupressus macrocarpa, host of Polyporus cutifractus, 322; Hydnum ochraceum on wood of, 320; Polyporus carbonarius on wood of, 322
Curly leaf of sugar beet, minimum incubation period of, 424–429
Curly top of sugar beet, 350
Currant, host of, Rhizopus nigricans, 279
Cuscuta sp., on onion, 53
Cutting instruments, disinfecting, 378
Cydonia, host of Rhizopus nigricans, 279
Cylindrocladium scoparium, on rose, losses from, 125–134
Cyphella marginata, on almond, 105; on peach, 105;
Cytospora, sp., on apple, 105; chrysosperma, on poplar, 45, 157–165; chrysosperma, on Acer spp., 157; chrysosperma, on Populus tremuloides, 157–165; chrysosperma, on Populus trichocarpa, 157; chrysosperma, on Populus grandidentata, 157–165; chrysosperma, on Prunus demissa, 157; chrysosperma, on Salix lasiandra, 157; chrysosperma, on Sambucus glauca, 157; chrysosperma, on Sorbus scopulina, 157; leucostoma, on apple, 237

Daedalea, cultures of, 154; unicolor on Salix sp., 326
Damping-off, direct inoculation, 80–84
DANA, B. F., Two new species of Sclerotinia, 106; Two new Sclerotinia diseases, 225-228
Datura stramonium, host of tomato mosaic, 47
Decay, of airplane timber, 45; of sweet potatoes by Rhizopus spp., 279-284
Dialonectria depallens, on Lupinus arboreus, 390
Diabrotica vittata, carrier of Bacillus tracheiphilus on cucumber, 299–300
Diaporthe lupini on Lupinus arboreus, 390
DICKSON, B. T. Studies on mosaic, 202
DICKSON, JAMES G., The influence of soil temperature on the development of the seedling blight of cereals caused by Gibberella saubinetii, 35–36
DICKSON, JAMES G., JOHANN, HELEN and WINELAND, GRACE, Second progress report on the Fusarium blight (scab) of wheat, 35
Diospyrus virginiana, wood stained by Ceratostomella spp., 214–224; wood stained by Lasiosphaeria pezizula, 214–224
Diplodia, sp., 33; rapax on Hevea brasiliensis, 46; lupini on Lupinus arboreus, 390
Direct inoculation, methods of, 80–84
Discomycetes, puffing of spores, 203
Disease, Fiji in Philippine, 251–252
Diseases, plant, relation to air temperature, 446–458
Disinfection, 6-17; of cutting instruments, 378
Dodder, on onion, 53
DOOLITTLE, S. P., Influence of temperature on the development of mosoaic-diseases, 46–47; The relation of wild host plants to the overwintering of curcurbit mosaic, 47; Overwintering of the bacterial wilt of cucurbits, 299–300; see JONES, L. R.
Douglas fir, decayed by Fomes officinalis, 173
Downy mildew, of lettuce, 54; of sugar cane, 371–375; of maize, 372
DRECHSLER, CHARLES, Occurrence of Rhyncosporium on Dactylis glomerata and Bromus inermis, 42
Drought, causing falling foliage of trees, 338–339
Dry rot, of alfalfa roots by Fusarium, 383
DUDDLESTON, B. H., and HOFFER, G. N. The improved rag-doll germinator as

an aid in controlling root, stalk, and ear-rots of corn, 33
DUFF, G. H., Development of the Geoglossaceae (title), 203
DUFRENOY, JEAN, Anaerobic bacteria in plant tissues, 344; Witches'-brooms of Pinus maritima, 27

Early blight, of potato, 182–193
Effect of treatment for bunt on the germination of wheat, 469–484
Eggplant, host of Phytophthora infestans, 504–505
ELLIOTT, JOHN A., A new Phoma disease of cotton, 48; A mosaic of sweet and red clovers, 146–148
ENLOWS, ELLA M. A., and RAND, FREDERICK V., A lotus leaf-spot caused by Alternaria **nelumbii**, sp. nov., 135–140
Epitrix cucumeris, 95
Eradication, of barberry, 4; of milkweed, 47; of wild cucumber, 47
Ergot of rye, losses from, 285–289
ERIKSSON, JAKOB, The mycoplasm theory—is it dispensable or not, 385–388; The life of Puccinia malvacearum Mont. within the host plant and on its surface, 459–463
ERWIN, A. T., see GILMAN, J. C.
ETTER, BESSIE E., Field cultures of wood-rotting fungi on agars, 151–154
Eucalyptus globulus, Polyporus schweinitzii on wood of, 323; host of Fomes applanatus, 326
European canker on the Pacific Slope, 464–468
Eutettix tenella, carrier of sugar beet curly leaf, 424–429
EVANS, NEVADA S., Black point of wheat, 515
Exobasidium sp., on Vaccinium parvifolium, 106
EZEKIEL, WALTER N., Some factors affecting the production of apothecia of Sclerotinia cinerea, 495–499

Fagus, sp., host of Thelephora terrestris, 141; atropunicea, wood discolored by Lasiosphaeria pezizula, 214–224; atropunicea, host of Fomes applanatus, 326
Falling foliage, of trees, 337–339
False mildew of tobacco from Dutch East Indies, 430–432
FARIS, JAMES A., Violet root-rot caused by Rhizoctonia crocorum D.C. in the United States, 412-423
FAULL, J. H. Studies in Fomes fomentarius (title), 203
Fermentation tubes, 21
FERNOW, KARL, see BLODGETT, F. M.
Fertilizers, affecting control of tomato leaf-spot, 433–445
FETHEROLF, N. J., see KORSTIAN, C. F.
Ficus, decayed by Rhizopus nigricans, 279
Fig, see Ficus
Fiji cane disease in Philippines, 251-252, 334–337
Fomes, sp., cultures of 154; annosus, on Thuja plicata, 176; applanatus, on wood of Tsuga heterophylla, 324; applanatus on wood of Picea sitchensis 324; applanatus on wood of Pseudotsuga taxifolia, 324; applanatus on wood of Abies concolor, 324; applanatus on Quercus alba, 325–326; applanatus on Quercus rubra, 326; applanatus on Quercus agrifolia, 326; applanatus on Fagus atropunicea, 326; applanatus on Eucalyptus globulus, 326; applanatus on Crataegus sp, 326; applanatus on Acacia sp., 326; applanatus on Schinus molle, 326; applanatus on Umbellularia californica, 326; fomentarius, 203; laricis, 45; meliae on living Ginkgo biloba, 324; officinalis, chlamydospores of, 173–175; pini on Thuja plicata, 176; pinicola, 45; pinicola on peach, 105; pinicola on prune, 105; pinicola on Abies concolor, 326; pinicola on Pinus lambertiana, 326; pinicola on Pseudotsuga taxifolia, 326; roseus on Pseudotsuga taxifolia, 326
Fomitiporia, cultures of, 154
Formaldehyde, effect on seed wheat, 103; 469–484; for oat smut, 149–150, 203; for potato scab 6–17, 59; for tobacco wildfire and angular spot, 48–49; injury to wheat seed, 103
Fragaria sp., decayed by Rhizopus nigricans, 279
FRASER, W. P., and BAILEY, D. L., Biologic

forms of wheat stem rust in western Canada, 202
FROMME, F. D., Incidence of loose-smut in wheat varieties, 507–510
FROMME, F. D., and WINGARD, S. A. Treatment of tobacco seed and suggested program for control of wildfire and angular-spot, 48–49
Fusarium, sp., 33, 34, 55; avenaceum, 35, 118; blight of wheat, 35, 115–124; causing celery yellows, 54–55; culmorum, 118; culmorum var. leteius, 35; dry rot of alfalfa roots caused by, 383; metochrorum, 118; moniliforme, 34, 35, 76; oxysporium, 56; roseum 118; subulatum, 118; willkommi imperfect stage of Nectria galligena, 464; wilt of corn, 33

Ganoderma sp., cultures of, 154
Garden pea, anthracnose of, 500–503
GARDNER, MAX W., and KENDRICK, JAMES B., Bacterial spot of tomato, 55; and GILBERT, W. W., Field tests with cucumber angular leaf-spot and anthracnose, 298–299; see Kendrick, James B.
GARRETT, A. O., Septoria negundinis Ellis & Ev. in Zion National Park, 100
Geoglossaceae, development of, 203
Gibberella saubinetii, 35, 36, 37; on wheat, 115–124; on corn seedlings, 35–36
GIDDINGS, N. J., Symposium on dusting at the Chicago meeting, 155
GILBERT, W. W., Sclerotium rolfsii on velvet beans, 378; see GARDNER, MAX W.
GILMAN, J. C., A Fusarium wilt of corn in Iowa in 1920, 33; and ERWIN, A. T., Greenhouse propagation of cabbage resistant to yellows, 54; see MELHUS, I. E.
GLOYER, W. O., Septoria leaf blight on China aster, 50–51
GODFREY, G. H., and HARVEY, R. B., Motion pictures of zoospore production in Phytophthora. 145–146
Gortyna immanis attacking Lupinus arboreus, 390
GUSSOW, H. T., Leaf curling in tomatoes, 380–383
Gymnosporangium macropus, internal aecia of 344

HARTER, L. L., WEIMER, J. L., and LAURITZEN, J. I., The decay of sweet potatoes (Ipomoea batatas) produced by different species of Rhizopus, 279–284
HARVEY, R. B., see WEISS, FREEMAN; see GODFREY, G. H.
HASKELL, R. J., Phytophthora infestans on eggplant in the United States, 504–505
HAYES, H. K., and STAKMAN, E. C., Resistance of barley to Helminthosporium sativum P. K. B., 405–411
Head smut of corn in Washington, 515
HEALD, F. C., Relation of spore load to the per cent of stinking smut (Tilletia tritici), 103–104; The skin spot (Oospora pustulans) of the Irish potato, 104–105; Some new hosts for the Rhizoctinia disease, 105; Moldy core of the Stayman Winesap, 105; The relation of spore load to the per cent of stinking smut appearing in the crop, 269–278
Heart rot, of peach trees, 105; of prune trees, 105;
Helminthosporium, sp., 2, 3, 37; avenae, 37; gramineum, 37; interseminatum, 37; sativum on barley, 405–411; sativum causing "black point" of wheat, 515
Hepialus sequoiolus, attacking Lupinus arboreus, 390
Herpotrichia pezizula, 214
HESLER, L. R., Review of ERWIN F. SMITH's An introduction to bacterial diseases of plants, 107–108
Heterodera radicicola, 93
Hevea brasiliensis, lightning injury of, 46
Hints for the young plant pathologist, 203–204
HOFFER, G. N., see DUDDLESTON, B. H., see TROST, JOHN F.; see SMITH, G. M.
Hollyhock rust, its life within the host plant and on its surface, 459–463
HOPKINS, E. F., Growth and germination of Gibberella saubinetii at varying hydrogen-ion concentrations, 36; Hydrogen-ion concentration of the soil

and seedling infection by Gibberella saubinetii, 36–37; Studies on the Cercospora leaf spot of bur clover, 311–318; Note on the hydrogen-ion concentration of potato dextrose agar and a titration curve of this medium with lactic acid, 491–494
Hopper burn of potato, 188–190
Hordeum vulgare, host of Helminthosporium sativum, 405–411
Hot air, seed treatment by, 471
Hotson, J. W., Collar rot on apple trees in the Yakima Valley (title), 105; A new species of Exobasidium, 106
Hottes, Chas. F., A constant humidity case, 51
Hot water treatment, for citrus root nematodes, 93; of seed corn, 470
Howitt, J. E., Experiments with Haskell's method, or the so-called dry formaldehyde treatment for the prevention of oat smut, 203
Hubert, Ernest E., A chisel forceps, 175; Notes on sap stain fungi, 214–224
Humidity regulating apparatus, 51, 446–458
Humphrey, H. B., see Whetzel, H. H.
Hungerford, Chas. W., A modification of the concentration formaldehyde method of seed treatment, 149–150
Hydnum, sp., cultures of, 154; ochraceum, on trunk of Cupressus macrocarpa, 320
Hydrated lime, for spraying potatoes, 182
Hydrogen-ion, 18–24, 36. 244–250; concentration of potato dextrose agar, 491–494
Hymenochaete tabacina, on wood of Tsuga canadensis and Sequoia sempervirens, 320
Hymenula lupini on Lupinus arboreus, 391
Hyoscyamus niger host of Peronospora hyoscyami, 430
Hypochnus sp., in cores of apples, 105

Imperial (British) Bureau of Mycology, 100
Incidence of loose smut in wheat varieties, 507–510
Inoculation, methods with damping-off fungi, 80–84; chambers, 510–512
Internal aecia, of Gymnosporangium macropus, 344; of Nigredo caladii, 344; of Puccinia albiperidia, 343–344; of Puccinia angustata, 344; of Puccinia cari-bistortae, 344; of Puccinia graminis, 344
Ipomoea batatas, decay by Rhizopus spp., 279–284
Irish potato, see potato
Iron, haematoxylin, 27; sulphate for spraying potatoes, 182.
Irpex, sp., cultures of, 154
Iva sp., killed by sunflower Sclerotinia, 49

Jackson, H. S., and Mains, E. B., The aecidium of the orange leaf rust of wheat, Puccinia triticina, 40; see Mains E. B.
Jennison, Harry Milliken, Observations upon the bacterial blight of field and garden peas in Montana, 104; Bacillus atrosepticus van Hall, the cause of the blackleg disease of Irish potatoes, 104
Johann, Helen, see Dickson, James G.
Johnson, A. G., Recognition of scientific accomplishments, 105; and Leukel, R. W., The nematode disease of cereals, 41; see McKinney, H. H.
Johnson, James, Inheritance of disease resistance to Thielavia basicola, 49; The use of sterilized soils in phytopathological research, 51; The relation of air temperature to certain plant diseases, 446–458
Jones, Fred Reuel, and Vaughan, R. E., Anthracnose of the garden pea, 500–503
Jones, L. R., and Williamson, Maude Miller, Bacterial leaf spot of red clover, 50; and Doolittle, S. P., Angular leaf-spot of cucumber, 297–298; and Keitt, G. W., Eugene Washburn Roark, 327; see Walker, J. C.
Juglans, nigra, causing wilting, 346; regia, anaerobic bacteria in diseased roots of, 349
Keitt, G. W., Second pogress report on, apple scab and its control in Wisconsin 43–44; see Jones, L. R.

KENDRICK, JAMES B., and GARDNER, MAX W., Seed transmission of soybean bacterial blight, 340–342; see GARDNER, MAX W.
KIRBY, R. S., see STAKMAN, E. C.
KOCH, ELIZABETH and RUMBOLD, CAROLINE, Phoma on sweet sorghum, 253–268
KORSTIAN, C. F., and FETHEROLF, N. J., Control of stem girdle of spruce transplants caused by excessive heat, 485–490
KULKARNI, G. S., The susceptibility of Dwarf Milo sorghum to smut, 252

Lactic acid, titration of media with, 491–494
Lactuca, canadensis, host of Bremia lactucae, 54; ludoviciana, host of Bremia lactucae, 54; sagittifolia, host of Bremia lactucae, 54; scariola var. integrata, host of Bremia lactucae, 54
Larix occidentalis, host of Thelephora caryophyllea, 144; host of Thelephora terrestris, 142
LARUE, CARL D., Lightning injury in Hevea brasiliensis, 46
Lasiosphaeria pezizula causing sap-stain in wood of beech, red gum and persimmon, 214–224
Late blight of potato, results of spraying for, 180–193; relation of air temperature to, 446–458
LAURITZEN, J. I., see HARTER, L. L.
Leaf, curl of tomatoes, 380–383; roll of potato, 58–59; scorch, of strawberry, 44; spot, angular, of cucumber, 297–299; spot, of lima bean, 52; spot, of lotus, 135–140; spot, of tomato, control of, affected by fertilizers, 433–445
LEE, H. ATHERTON, The increase in resistance to citrus canker with the advance in maturity of citrus trees, 70–73; see MCLEAN, FORMAN T.; see LYON, H. L.
LEHMAN, S. G., Soft rot of pepper fruits, 85–87
Lenzites, sp., cultures of, 154; saepiaria on living peach and prune trees, 105; saepiaria on wood of Populus tremuloides, 324; saepiaria on living Alnus incana, 324
LEONIAN, LEON H., Studies on the Valsa apple canker in New Mexico, 236–243
Leptosphaeria circinans, 414
Lettuce, host of Bremia lactucae, 54
LEUKEL, R. W., see JOHNSON, A. G.
Libocedrus decurrens, host of Polyporus amarus, 176; Stereum hirsutum on wood of, 320; Polystictus versicolor on wood of, 321
Lightning injury, to cabbage, 97–98; to Hevea brasiliensis, 46; to potato, 96–97
Lima bean, bacterial leaf spot of, 52
Lime, for potato spraying, 189, 192; for bunt of wheat, 471–484; following treatment with other chemicals, 471–484; affecting control of tomato leaf spot, 433–445
Lime and sulphur mixture, liquid and dust, for brown rot, 43
Lime-sulphur, for apple scab, 43–44; for potato spraying, 185, 189
LIPMAN, C. B., A contribution to our knowledge of soil relationships with citrus chlorosis, 301–305
Liquidambar styraciflua, see red gum
Literature list of phytopathology, 101
Litmus agar, 20, 22
Loblolly pine, see Pinus taeda
Longleaf pine, see Pinus palustris
Loose smut, incidence in wheat varieties, 507–510
Lotus, leaf spot of, caused by Alternaria **nelumbii** n. sp., 135–140
Low temperature, cause of falling foliage of trees, 338
Lupinus, arboreus, host of Collybia velutipes, 389–404; host of Pleurotus ostreatus, 389–404; host of Armillaria mellea, 391–392; attacked by Hepialus, sequoiolus, 390; attacked by Gortyna immanis, 390; Diplodia lupini on, 390; Stictis lupini on, 390; Diaporthe lupini, on, 390; Dialonectria depallens on, 390; Sphaeria lupini on, 390; Stictus decipiens on 390; Metasphaeria lathyri on, 390; Pleospora leguminum on, 390; Phoma lupini on, 390; Sphaeropsis lupini on, 391; Hymenula lupini on,

391; Valsa lupini on, 391; Sordaria lanuginosa on, 391
Lupinus chamissonis, host of Colybia velutipes, 394
Lycopersicon esculentum, host of Rhizopus nigricans, 279
LYMAN, G. R., Report of the twelfth annual meeting of the American Phytopathological Society, 194–201
LYON, H. L., and LEE, H. ATHERTON, citrus canker in the Hawaiian Islands, 377
MCALPINE, D., Bitter pit in apples and pears: the latest results in preventive measures, 366–370
MCCLINTOCK, J. A., The control of peach brown rot and curculio, 43; Overwintering of mosaic of annuals, 47
MCCUBBIN, W. A., The present status of the potato wart in Pennsylvania, 58
MCFARLAND, FRANK T., Infection experiments with Claviceps, 41–42; see SEYMOUR, EDITH K.
MCKINNEY, H. H., The so-called take-all disease of wheat in Illinois and Indiana, 37; and JOHNSON, A. G., Wojnowicia graminis (McAlp.) Sacc. and D. Sacc. on wheat in the United States, 505–506
MCLEAN, FORMAN T., and LEE, H. ATHERTON, The resistance to citrus canker of Citrus nobilis and a suggestion as to the production of resistant varieties in other citrus species. 109–114a
MCMURRAN, STOCKTON MOSBY, biographical sketch and portrait, 25–26
MACKIE, W. W., and BRIGGS, FRED N., Chemical dusts for the control of bunt, 38–39
Macrosiphum solanifolii, 95
Macrosporium, sp., on onion, 53; foot rot, of tomato, 29; solani, on tomato, 29
MAINS, E. B., and JACKSON, H. S., Two strains of Puccinia triticina on wheat in the United States, 40; see JACKSON, H. S.
Maize, Sclerospora spontanea on, 372
Malva silvestris, host of Puccinia malvacearum, 463
Marasmius sp., cultures of, 154
Marssonia, potentillae, on strawberry, 44
MARTIN, WILLIAM H., Inoculated vs. uninoculated sulfur for the control of common scab of potatoes, 58
Martynia louisiana, host of cucurbit mosaic, 47
MASSEY, L. M., Experimental data on losses due to crown-canker of rose, 125–134
MEDALLA, MARIANO G., Fiji disease of sugar cane in the Philippine Islands, 251–252
Medicago, arabica, mosaic of, 147; maculata, host of Cercospora medicaginis, 311–318; sativa, 146; sativa, host of Rhizoctonia crocorum, 412
Melampsora salicina, 388
MELCHERS, L. E., Ecologic and physiologic notes on corn smut, Ustilago zeae, 32; Rhizopus sp. associated with a decay of unripe strawberries in the field, 44
MELHUS, I. E., Bremia on hothouse lettuce 54; Cooperative potato seed treatment experiments, 59–60; and GILMAN, J. C., Measuring certain variable factors in potato seed treatment experiments, 6–17
Melilotus alba, mosaic of, 146–148
Mercuric chloride, for potato seed treatment, 6–17, 59–60
Metasphaeria lathyri, on Lupinus arboreus, 390
Micrampelis lobata, 299; eradication of, 47; host of cucurbit mosaic, 47
Micrococcus, phytophthorus, 104
Microsphaera euonymi, 388
Mildew, of rose, 128; downy of sugar cane, 371–375; false, of tobacco from Dutch East Indies, 430–432
Milkweed, eradication of, 47
Minimum incubation period of curly leaf of sugar beet, 424–429
Mistletoe, mucilage of berries an adhesive, 99
Mollisia earliana, perfect stage of Marssonia potentillae, 44
Mollisiose of strawberry, 44
Monilia, see Sclerotinia
MONTEITH, JOHN, JR., Seed transmission and overwintering of cabbage black rot, 53–54

MORRIS, H. E., and SWINGLE, D. B., An important new disease of the cultivated sunflower, 50
MORSE, W. J., The transference of potato blight by insects, 94–96
Mosaic, 202; of cucumbers, 28–29, 47; diseases influenced by temperature, 46–47; carried by Myzus persicae, 349–365; of Physalis longifolia, 47; of potato, 58–59; of sweet and red clover, 146–148; of Trifolium repens, 146; of Vicia faba, 202; of raspberry, 202; of sugar beets, 349–365; of tobacco, 388; of tobacco, relation to air temperature to 446–458; wild host plants of cucurbit mosaic, 47
Mummies, brown rot, 176–177
Mycoplasm theory, is it dispensable or not, 385–388
Mycosphaerella **rubi** on Rubus spp., 328–331; perfect stage of Septoria rubi, 328–333
Myzus persicae carrier of sugar beet mosaic, 349–365

Nectria, cinnabarina, 467; galligena on apple and pear, 464–468
Negundo, host of Septoria negundinis, 100
NELSON, RAY, Tissue breakdown in fruits and vegetables, 44; see Coons, G. H.
Nelumbium speciosum, host of Alternaria **nelumbii** sp. nov., 135–140
Nematode, disease of cereals, 41
Neofabraea melicorticis, 466–467
NEWTON, MARGARET, Biologic forms of wheat rust in Canada, 202
Nicandra physalodes, host of tomato mosaic, 47
Nicotiana glauca, 430
Nigredo caladii, internal aecia of, 344
Northern white cedar, see Thuja occidentalis
Note on the hydrogen-ion concentration of potato dextrose agar and a titration curve of this medium with lactic acid, 491–494

OBERLY, E. R., List of literature on phytopathology, 101
Onion, Cuscuta sp. on, 53; rust of, 87–90; Puccinia asparagi on, 87–90, smut of, 52–58; Macrosporium rot of, 53; Botrytis sp. on, 87–90; Rhizoctonia on, 105
Ophiobolus graminis, 505
Orange leaf rust, 40
Orthocarpus sp., host of Peridermium filamentosum, harknessi and stalactiforme, 45
ORTON, C. R., Lightning injury to potato and cabbage, 96–98; and WEISS, FREEMAN, The reaction of first generation hybrid potatoes to the wart disease, 306–310; see WEISS, FREEMAN
ORTON, W. A., Compilation of list of new fungi, 29–30
OWENS, C. E., see ZELLER, S. M.

PALM, B. T., The false mildew of tobacco introduced into the United States from the Dutch East Indies? 430–432
Paraformaldehyde for seed treatment, 473
PARKER, CHAS. S., Head smut of corn in Washington, 515
Pea, bacterial blight of, 104
Peach, blossom blight of, 43, 290–294; control of brown rot of, 43; host of Cyphella marginata, 105; host of Lenzites saepiaria, 105; host of Fomes pinicola, 105; host of Sclerotinia cinerea, 43, 176–177; host of Trametes carnea, 105
Pear, bitter pit of, 366–370; blight, caused by Botrytis sp., 105; decayed by Rhizopus nigricans, 279; European canker of, on Pacific Slope, 464–468
Pecan, diseases, 26; rosette, 26; wood rot, 26.
Pedicularis sp., host of Peridermium filamentosum, 45; host of P. harknessii 45; host of P. stalactiforme, 45.
Penicillium sp., 13; in cores of apples, 105
PENNINGTON, L. H., SNELL, W. H., YORK H. H., and SPAULDING, Perley, Investigations of Cronartium ribicola in 1920, 170–172
Pepper, host of cucurbit mosaic, 47; fruit rot by Pythium deBaryanum, 85–87
Peridermium, cerebrum on Quercus sp., 45; cerebrum, new hosts of, 45; fila-

mentosum, on Pinus sp., 45; filamentosum, on Castilleja sp., 45; filamentosum, on Orthocarpus sp., 45; filamentosum, on Pedicularis sp., 45; filamentosum, on Adenostegia sp., 45; harknessii, on Pinus sp., 45; harknessi on Castilleja sp., 45; harknessii, on Orthocarpus sp., 45; harknessii, on Castilleja sp., 45; harknessii, on Orthocarpus sp., 45; harknessii, on Pedicularis, sp., 45; harknessii, on Adenostegia sp., 45; stalactiforme, on Adenostegia sp., 45; stalactiforme, on Castilleja sp., 45; stalactiforme, on Orthocarpus sp., 45; stalactiforme, on Pedicularis, sp., 45;

Peronospora, ficariae, 388; hyoscyami, on tobacco, origin in Dutch East Indies? 430–432; hyoscyami, on Hyoscyamus niger, 430; hyoscyami, on Nicotiana glauca, 430; spinaciae, on spinach, 386–388; trifoliorum, 388

Persimmon wood stained, by Ceratostomella sp., 214–224; by Lasiosphaeria pezizula, 214–224

Personals, 30, 102, 177, 252, 348, 383–384, 516

Petri dish cultures, for direct inoculation of conifer seedlings, 82–84

Pholiota sp., cultures of, 154

Phoma, sp., on cotton, 48; insidiosa, on sorghum, 253–268, 513–514; insidiosa, on Sudan grass, 345; lupini, on Lupinus arboreus, 390

Phoradendron, mucilage of berries, 99

Phragmidium, potentillae, 388; subcorticium, 388

Physalis longifolia, host of tomato mosaic, 47

Phytopathological, research in Russia, 156; Society, American, see American Phytopathological Society; Society of France, 100–101; Society in the Philippines, 516

Phytophthora sp., 145–146; cryptogea, 29; foot rot, 29; infestans, 386–387; infestans, transference of, 94–96; infestans, on Solanum melongena, 504–505; infestans, relation to air temperature, 446–458; rot of rhubarb, 55–56; infestans, on eggplant in the United States, 504–505

Picea, engelmanni, host of Polyporus dryadeus, 99; engelmanni, host of Thelephora terrestris, 142; engelmanni, control of stem girdle of, caused by heat, 485–490; excelsa, anaerobic bacteria from tumors of, 344; mariana, host of Thelephora terrestris, 142; rubens, host of Schizophyllum commune 320; sitchensis, host of Polyporus berkeleyi, 323; sitchensis, Fomes applanatus on wood of, 324; sitchensis, Polyporus caesius on wood of, 321; sitchensis, Polystictus versicolor on wood of, 321

Pickering's solution, 194

Pilobolus sp., 204

Pinon blister rust, 105

Pinus, cembra, 171; contorta, host of Cenangium **piniphilum** 294–296; con, torta, host of Thelephora terrestris-142; densiflora, 171; divaricata, host of Thelephora terrestris, 142; echinata, wood stained by Ceratostomella sp., 214–224; flexilis, host of Cronartium ribicola, 171; koraiensis, host of Cronartium ribicola, 171; lambertima, host of Fomes pinicola, 326; maritima, witches' brooms of, 27; monophylla, host of Cronartium occidentale, 46; monticola, host of Thelephora terrestris, 142; monticola, wood stained by Ceratostomella sp., 214–224; mugho, 171; palustris, 221; ponderosa, host of Cenangium piniphilum, 294–296; ponderosa, host of Thelephora terrestris, 142; ponderosa, host of Thelephora fimbriata, 143; ponderosa, host of Cenangium abietis, 166–169; ponderosa, host of Fomes officinalis, 173; ponderosa, wood stained by Ceratostomella sp., 214–224; radiata, Stereum hirsutum on wood of, 320; radiata, Polystictus versicolor on wood of, 320; radiata, Polyporus dichrous on wood of, 323; rigida, host of Thelephora fimbriata, 144; sabiniana, Polystictus hirsutus on wood of, 321; strobus, host of Cenangium abietis, 166; strobus, host of Thele-

phora terrestris, 141; strobus, host of Crenartium ribicola, 171; strobus, wood stained by Ceratostomella sp., 214–224; sylvestris, 171; taeda, wood stained by Ceratostomella sp., 214–224; virginiana, wood stained by Ceratotosmella sp., 214–224
Pisum, elatius, host of Colletotrichum pisi, 500–503; jomardi, host of Colletotrichum pisi, 500–503; sativum, host of Colletotrichum pisi, 500–503
Plant disease survey of England and Wales, 376
Plasmodiophora brassicae, 433
Platanus occidentalis, host of Polyporus gilvus, 325
Pleospora leguminum on Lupinus arboreus 390
Pleurotus, sp., cultures of, 154; ostreatus on Lupinus arboreus, 389–404
Plum, host of Sclerotinia cinerea, 176-177; fruit decayed by Rhizopus nigricans, 279
Poa pratensis, 42
Poke, mosaic of, 47
Polychrome-blue-tannin-orange, 27
Polyporus sp., cultures of, 154; amarus, 176; berkeleyi, on Picea sitchensis, 323; caesius, on wood of Picea sitchensis, 321; cutifractus, on Cupressus macrocarpa, 322; dryadeus, on conifers, 99; dryadeus wood of Abies concolor, 323; dryadeus, on wood of Abies grandis, 323; dichrous, on wood of Pinus radiata 323; perennis, 143; picipes, on wood of Abies balsamea, 323; carbonarius, on wood of Cupressus macrocarpa, 322; gilvus, on Acer saccharinum, 325; gilvus, on Platanus occidentalis, 325; gilvus, on Quercus coccinea, 325; gilvus, on Rhus toxicodendron, 325; leucospongia, on wood of Populus tremuloides, 322; nidulans, on wood of Tsuga canadensis, 323; schweinitzii, 45; schweinitzii, on Thuja plicata, 176; schweinitzii, on stump of Eucalyptus globulus, 323; sulphureus, on Thuja plicata, 176
Polystictus, sp., cultures of, 154; abietinus, on wood of Quercus sp., 321; hirsutus, on wood of Pseudotsuga taxifolia, 321; hirsutus, on wood of Pinus sabiniana, 321; hirsutus, on wood of Aesculus californica, 321; hirsutus, on Prunus sp., 325; versicolor, on wood of Pinus radiata, 320; veriscolor, on wood of Picea sitchensis, 321; veriscolor, on wood of Pseudotsuga taxifolia, 321; versicolor, on wood of Abies concolor, 321; versicolor, on wood of Sequoia sempervirens, 321; versicolor, on wood of Tsuga heterophylla, 321; versicolor, on wood of Libocedrus decurrens, 321
POOLE, R. F., Recent studies on bacteriosis of celery, 55
Poplar canker, caused by Cytospora chrysosperma, 45, 157–165
Populus, caroliniana, host of Cytospora chrysosperma, 45; deltoides, host of Cytospora chrysosperma, 163-165; grandidentata, host of Cytospora chrysosperma, 45, 158–165; tremuloides, host of Cytospora chrysosperma, 45, 158–165; tremuloides, wood stained by Ceratostomella sp., 214-224; tremuloides, Polyporus leucospongia on wood of, 322; tremuloides, Lenzites saepiaria on wood of, 324; trichocarpa, host of Cytospora chrysosperma, 157
Poria, sp., cultures of, 154; weirii, on Thuja plicata, 176
PORTE, W. S., see PRITCHARD, FRED J.
PORTER, R. H., Cooperative seed treatment using hot formaldehyde, 59
POSEY, GILBERT B., see BETHEL, ELLSWORTH
Potassium, sulphide for seed treatment, 471; sulphate, effect for control of tomato leaf spot, 435,
Potato, black leg of, caused by Bacillus atrosepticus, 104; cooperative spraying report, 178–193; dextrose agar, hydrogen-ion concentration of, 491–494; early blight of, 180–193; late blight of, spraying for, 180–193; late blight of, transference of, 94–96; late blight of, relation to air temperature, 446–458 leaf roll of, 58–59; lightning injury of, 96–97; mosaic of, 47; mosaic of, testing for, 58–59; scab, 6–17, 58–59; seed

treatment of, 58–60, 150–151; skin spot of caused by Osopora pustulans, 104; spraying of, 178–133; tip burn of, 56–57; wart of, susceptibility tests for 57; wart of, enzyme activity of, 57; wart of, status in Pennsylvania, 58; wart of, heredity of resistance to, 306–310

POVAH, ALFRED H. W., Valsa poplar canker, 45 An attack of poplar canker following fire injury, 157–165

Pre soaking seed before treatment with chemicals, 473–474

PRITCHARD, FRED J. and PORTE, W. S., Use of copper soap dust as a fungicide, 229–235; Effect of fertilizers and lime on control of tomato leaf spot (Septoria lycopersici), 433–445

Production of apothecia of Sclerotinia cinerea, factors affecting, 495–499

Prune heartrot, caused by Fomes pinicola, 105; by Lenzites saepiaria, 105; by Trametes carnaca, 105

Prunus, sp., decayed by Rhizopus nigricans, 279; host of Polystictus hirsutus, 325; demissa, host of Cytospora chrysosperma. 157; demissa, host of Sclerotinia **demissa**, 227–228

Pseudomonas, sp., on red clover, 50; citri, on Citrus spp., 109–114

Pseudotsuga taxifolia, host of Thelephora terrestris, 142; Polystictus versicolor on wood of, 321; Polystictus hirsutus on wood of, 321; Fomes applanatus on wood of, 324; host of Fomes pinicola 326; host of Fomes roseus, 326

Puccinia albiperidia, internal aecia of, 343–344; angustata, internal aecia of 344; asparagi, on onion, 87–90; caribistortae, internal aecia of, 344; chrysanthemi, 388; glumarum, 4, 205, 385; graminis, effect on F_2 generation of wheat (durum X vulgare), 205–213; graminis, internal aecia of, 344; malvacearum, 459–463; Ribis, 388; sorghi, 31–32; suaveolens, 388; tragopogonis, 388; triticina, 40

PUTTICK, G. F., The reaction of the F_2 generation of a cross between a common and a durum wheat to two biologic forms of Puccinia graminis, 205–213

Pyrus malus, decayed by Rhizopus nigricans, 279

Pythium de Baryanum, on pepper fruits, 85–87

Quercus, sp., host of Cronartium cerebrum 45; alba, host of Thelephora terrestris, 142; alba, host of Fomes applanatus, 325–326; alba, Polystictus abietinus on wood of, 321; agrifolia, host of Fomes applanatus, 326; coccinea, host of Polyporus gilvus, 325; rubra, host of Fomes applanatus, 326

Quince, host of Rhizopus nigricans, 279

RAND, FREDERICK V., see ENLOWS, ELLA M. A.

Raspberry, decayed by Rhizopus nigricans 279; mosaic of, 202

RATHBUN, ANNIE E., Methods of direct inoculation with damping-off fungi, 80–84

RAVN, F. KOLPIN, biographical sketch and portrait, 1-5; reprints of biography and portrait, 101–102

Ravn Scandinavian-American fellowship in plant pathology, 348

Razcumofskya, mucilage of berries of, 99

Red gum, wood stained by Ceratostomella sp., 214–224; wood stained by Lasiosphaeria pezizula, 214-224

Red heart of lettuce, 44,

Red raspberry, decayed by Rhizopus nigricans, 279

REDDICK, D. Foot rot of tomato, 29; New abstract Journal Zentralblatt fur die gesamte Landwirtschaft mit Einschluss der Forst- und Teichwirtschaft, der Tier-Pathologie und Medizin., 29

REDDY, CHAS. H., Experiments with Stewart's disease on dent, flint and sweet corn, 31

REINKING, OTTO A., Fiji disease of sugar cane in the Philippine Islands, 334–337

Resistance, of corn to rots, 33-34; of wheat to take-all, 37; of wheat to nematodes, 41; of tobacco to Thielavia basicola, 49; of China asters to Septoria callistephi, 50; of celery to yellows, 54–

55; to bacterial rots, 55; of potatoes to wart, 57; of citrus to canker, increase in resistance with age of tree, 70–73; of Citrus nobilis to canker, 109–114; of potatoes to late blight, 183–184, 185, 193; of strawberries to moliisiose, 202–203; of Dwarf Milo sorghum to Sphacelotheca sorghi and S. cruenti, 252; of sugar cane to Fiji disease, 336–337; of barley to Helminthosporium sativum, 405–411

Rhizoctonia sp. on bean seedlings, 63; on onions, 105; on potato, 105; on strawberries, 105; corrosive sublimate treatment for, 150–151; crocorum on Solanum tuberosum, 412–423; on alfalfa, 417–423; solani, 6–7, 9–17, 56, 59–60, 412, violacea, synonym of R. crocorum, 413; medicaginis, 414

Rhizopus, sp., 13; sp., causing strawberry rot, 44; arrhizus, 281–284; artocarpi, 281–284; chinensis, 281–284; delemar, 281–284; maydis, 281–284; microsporus, 281–284; nigricans, 279–294; nodosus, 281–284; oryzae, 281–284; reflexus, 281–284; tritici, 281–284

Rhoads, Arthur S., Some new or little known hosts for wood-destroying fungi. III., 319–326; The pathology of Lupinus arboreus, with special reference to the decays caused by two wound-parasites—Collybia velutipes and Pleurotus ostreatus, 389–404

Rhubarb, Phytophthora rot of, 55–56, 145–146

Rhus, hirta, Schizophyllum commune on, 325; toxicodendron, host of Polyporus gilvus, 325; vernix, Schizophyllum commune on, 325

Rhyncosporium secalis, on Bromus inermis 42; on Dactylis glomerata, 42

Ribes sp., host of Cronartium occidentale, 46; decayed by Rhizopus nigricans, 279; cynosbati, host of Cronartium ribicola, 170; glandulosum, host of Cronartium ribicola, 170–171; glandulosum, host of Puccinia albiperidia, 343–344; prostratum, host of Thelephora terrestris, 142; rotundifolium, host of Cronartium ribicola, 170

Rice, Sclerotium oryzae on, 42; Sclerotium rolfsii on, 42; seedling blight of, 42; stem rot of, 42; straighthead of, 42–43

Richards, B. L., A dry rot of the sugar-beet caused by Corticium vagum, 48; The pathogenicity of Corticium vagum as affected by soil temperature, 56; Pathogenicity of Rhizoctonia and the fungus as a factor in crop production (title), 106; Soil temperature as a factor in influencing pathogenicity of Rhizoctonia with special reference to the potato (title), 106

Roark, Eugene Washburn, biographical sketch of, 327; The Septoria leaf spot of Rubus, 328–333

Robbins, W. W., Mosaic of sugar beets, 48; Mosaic disease of sugar beets, 349–365

Roberts, John W., Stockton Mosby McMurran, biographical sketch and portrait, 25–26; The age of brown-rot mummies and the production of apothecia, 176–177

Root rot, violet, caused by Rhizoctonia crocorum, 412–423

Rose, black spot of, 128; crown canker of, 125–134; mildew, 128

Rosen, H. R., A bacterial root and stalk rot of field corn, 32–33; Further observations on a bacterial root and stalk rot of field corn, 74–79

Rubus sp., decayed by Rhizopus nigricans, 279; sp., host of Septoria **rubi**, 328–331; sp., host of Mycosphaerella **rubi**, 328–331; allegheniensis, host of Mycosphaerella **rubi**, 329; hispidus, host of Mycosphaerella **rubi**, 329; parviflorus, host of Mycosphaerella **rubi**, 329; strigosus, host of Mycosphaerella **rubi**, 329

Rumbold, Caroline, and Tisdale, Elizabeth K., Notes on Phoma insidiosa Tass. found on Sudan grass, 345; Phoma insidiosa on sorghum, 513–514; see Koch, Elizabeth;

Russian Mycological and Phytopathological Society, 346–347

Rye ergot, 41; loss from, 285–289

Saccharum spontaneum, resistant to Fiji disease, 337
Salix sp., host of Daedalea unicolor, 326; sp., host of Trametes suaveolens, 326; lasiandra, host of Cytospora chrysosperma, 157
Sambucus glauca, host of Cytospora chrysosperma, 157
Scab, of apple, 43–44; of potato, 6–17, 58; of wheat, 115–124
Schinus molle, host of Fome applanatus, 326
Schizophyllum commune, on Picea rubens, 320; on Abies concolor, 320; on Sequoia sempervirens, 320; on Rhus hirta, 325; on Rhus vernix, 325; on Cedrela sinensis, 325; on Acer platanoides, 325; on Ceanothus thyrsiflorus, 325; on Acacia melanoxylon, 325; on Acacia spp., 325
Sclerospora, sacchari, on sugar cane, 371–375; spontanea, on sugar cane, 372; spontanea on maize, 372
Sclerotinia sp., on sunflowers, 49, 50; cinerea, on peach, 43, 176–177, 290-294; cinerea, on plum, 176–177; cinerea, factors influencing production of apothecia of, 495–499; **demissa**, on choke cherry, 106; **demissa**, on Prunus demissa 227–228; fructigena on apples, 495; gregaria, on Amelanchier cusickii, 106 225–226; laxa, on apricots, 495
Sclerotium, oryzae, 42; rolfsii, 42; rolfsii, on velvet bean, 378
Scrub pine, see Pinus virginiana.
Seed, coat cracking of, leading to injury from seed treatment, 469–484; treatment, injury from, 103; treatment, of corn, 35, 37; treatment of potato, 6-17, 59, 150–151; treatment of tobacco, 48–49; treatment of tomato, 55; treatment of wheat, 38–39; treatment of wheat with various chemicals, 469-484; treatment followed by lime bath, 469–484
Septoria, callistephi, attacking Callistephus chinensis, 50; lycopersici, 379; lycopersici controlled by copper soap dust, 229-235; lycopersici, control of, effected by fertilizers and lime, 433-445; negundinis on box elder, 100; rubi on Rubus spp., 328–331, rubi imperfect form of Mycosphaerella **rubi** 328–331
Sequoia sempervirens, Schizophyllum commune growing on wood of, 320; Hymenochaete tabacina on wood of, 320; Polystictus versicolor, on wood of, 321
SEVERIN, HENRY H. P. Minimum incubation periods of causative agent of curly leaf in beet leafhopper and sugar beet, 424–429
SEYMOUR, EDITH K. and MCFARLAND, FRANK T. Loss from rye ergot, 41; 285–289
SHAPOVALOV, M., Phytopathological research in Russia, 156; Russian Mycological and Phytopathological Society, 346–347
Shortleaf pine, see Pinus echinata.
SHUNK, I. V. and WOLF, F. A., Further studies on bacterial blight of soybean, 18–24; Soybean bacterial blight, 52; see WOLF, FREDERICK A.
Sicyos angulata, 299
Silver fir, host of Thelephora terrestris, 141
SLAGG, C. M., A new seedling disease of tobacco, 49
SMITH. G. M. and HOFFER, G. N., Three methods of controlling the root, stalk and ear rots of corn, 34
Smut, head, of corn in Washington, 515; of onion, 52–53; of sorghum, 252; of wheat, 269-278
SNELL, W. H., Chlamydospores of Fomes officinalis in nature, 173–175; see PENNINGTON, L. H.
Sodium, chloride, 37–38; nitrate, effect on control of tomato leaf spot, 433–445
Soil relationships to citrus chlorosis, 301–305
Solanum, dulcamara, host of tomato mosaic, 47; melongena, host of Phytophthora infestans, 504–505; nigrum, host of tomato mosaic, 47; tuberosum, host of Rhizopus nigricans, 279; tuberosum, host of Rhizoctonia crocorum, 412–422; tuberosum, host of Rhizoctonia solani, 412

Solutions of sugar, 21–23
Some factors affecting the production of apothecia of Sclerotinia cinerea, 495–499
Sorbus scopulina, host of Cytospora chrysosperma, 157
Sorghum susceptible to smuts, 252; sweet, host of Phoma insidiosa, 253, 268, 513-514
Sow thistle, killed by sunflower Sclerotinia, 49
Soybean, bacterial blight of, 18–24, 52; seed transmission of bacterial blight, 340–342; blight, caused by Bacterium glycineum, 18–24, 52, 340–342; blight, caused by Bacterium sojae, 18–24, 52, 340–342
SPAULDING, PERLEY, see PENNINGTON, L H.; Plant disease survey of England and Wales, 376; Bibliographie der Pflanzenschutzliteratur, Das Jahr 1920 377
Sphacelotheca, cruenti, 252; reiliana, on corn in Washington, 515; sorghi, 252
Sphaeria lupini, on Lupinus arboreus, 390
Sphaeropsis lupini, on Lupinus arboreus, 391
Sphaerotheca, mors-uvae, 388; pannosa, 388; pannosa var. rosae, on rose, 128
Spore load of seed, relation to smut in crop, 103–104
Spot blotch disease of barley, 405–411
Spray injury causing falling of foliage of trees, 339
Spraying, of potato, 178-193
Spruce, host of Thelephora terrestris, 141
STAKMAN, E. C., KIRBY, R. S. and THIEL, A. F., The regional occurrence of Puccinia graminis on barberry, 39–40; see HAYES, H. K.
Stayman Winesap, moldy core of, 105
Stem, girdle of coniferous seedlings, control of, 485–490; rust of wheat, 202
Stereum, sp., cultures of, 154; hirsutum, on wood of Pinus radiata, Libocedrus decurrens, Abies concolor and Sequoia sempervirens, 320
STEVENS, F. L., Helminthosporium and wheat foot-rot, 37
Stewart's disease, of corn, 31
Stictis, lupini on Lupinus arboreus, 390; decipiens on Lupinus arboreus, 390
Stinking smut, relation of spore load of seed to smut in crop, 269-278
STONE, R. E., Leaf scorch or mollisiose of strawberry, 44; 202–203
Strawberry, fruit decayed by Rhizopus nigricans, 44, 279; host of Marssonia potentillae, 44, 202; host of Mollisia earliana, 44; leaf scorch, 44, 202; mollisiose of, 44, 202; host of Rhizoctonia, 105
Stripe rust, of wheat, 4
Sudan grass, host of Phoma insidiosa, 345
Sugar beet, curly leaf, carried by Eutettix tenella, 424–429; host of Corticium vagum, 48; mosaic of, 48, 349–365; transmitted by aphids, 349–365; carried by Myzus persicae, 349–365
Sugar cane, downy mildew of, in Philippines, 371–375; Fiji disease of, 251–252 334–337; mosaic of, 47; Sclerospora sacchari on, 371–375; Sclerospora spontanea on, 372
Sulphur, dioxide for seed treatment, 470; for potatoes, 185; ground for rose mildew, 128; inoculated for potato scab, 58
Sulphur and lime, dust for brown rot, 43; spray for brown rot, 43
Sulphuric acid for seed treatment, 470
Summer field meeting of cereal pathologists, 177
Sunburn of tomatoes, 379–380
Sunflower, Sclerotinia disease of, 49–50
Sunscald causing falling foliage of trees, 338–339
Susceptibility of Dwarf Milo sorghum to smuts, 252
Sweet potato, decay by Rhizopus spp., 279–284
Sweet sorghum, host of Phoma insidiosa, 253–268
SWINGLE, D. B., see MORRIS, H. E.
Symposium on dusting, 155
Systemic disease, bacterial bean blight, 61-69

TAYLOR, MINNIE W., Internal aecia of Puccinia albiperidia Arthur, 343-344

Temperature, affecting pathogenicity of Corticium vagum, 56; regulating apparatus, 446–458; air, relation to plant diseases, 446–458
Thalictrum sp., host of Puccinia triticina, 40
Thelephora, caryophyllea, 144; fimbriata, 143–144; galactina, 141; intybacea, 142; terrestris, 141–143
THIEL, A. F., see STAKMAN, E. C.
Thielavia basicola, 433; breeding tobacco resistant to, 49; on bean seedlings, 63
THOMPSON, NOEL F., The effect of certain chemicals especially copper sulphate and sodium chloride on the germination of bunt spores, 37–38
Thuja plicata, host of Thelephora terrestris, 142; plicata, host of Polyporus schweinitzii, 176; plicata, host of Poria weirii, 176; plicata, host of Fomes pini, 176; plicata, host of Fomes annosus, 176; plicata, host of Polyporus sulphureus, 176; plicata, host of Armillaria mellea, 176; occidentalis, sap stained by Ceratostomella sp., 214–224
THURSTON, H. W. JR., A note on the corrosive sublimate treatment for the control of Rhizoctonia, 150–151
Tilletia, laevis, 37–38; tritici, 37–38, 39; triticina, spore load of seed, relation to smut in crop, 103–104; triticina, effect of treatment for, on germination of wheat, 469–484
Tip burn, 56–57, 182–193
TISDALE, ELIZABETH K., see RUMBOLD, CAROLINE
TISDALE, W. H., Two Sclerotium diseases of rice, 42; and JENKINS, J MITCHELL, Rice straighthead and its MAUED control, 42–43; and WILLIAMSON, MAUDE MILLER, Bacterial leaf spot of lima bean, 52
Tissue break-down of cabbage, 44; of citrus fruits, 44; of lettuce, 44
Titration of potato dextrose agar with lactic acid, 491–494
Tobacco, false mildew of, introduced into United States from Dutch East Indies? 430–432; angular spot of, 48–49; host of Thielavia basicola, 49; mosaic of, 47, 388; mosaic, relation of air temperature to, 446–458; seedling disease caused by Fusarium, 49; wildfire, 48–49; wildfire, relation of air temperature to, 446–458
Tolerance to acids by bacteria, 244–250
Tomato, bacterial spot of, 55; foot rot of, 29; fruit rots, 379–380; host of Rhizopus nigricans, 279; leaf curl of, 380–383; leaf spot, control of, influenced by fertilizers, 433–445; mosaic of, 47; mosaic transferred to Solanum dulcamara, S. nigrum, Physalis longifolia, Nicandra physalodes, and Datura stramonium, 47; overwintering of mosaic of, 47; sunburn of, 379–380
Trametes, sp., cultures of, 154; carnea on peach and plum trees, 105; heteromorpha, on wood of Tsuga canadensis, 326; pini, 45; suaveolens, on Salix sp., 326
Trees, falling foliage of, 337–339
Trifolium, medium, bacterial disease of, 50; pratense, bacterial disease of, 50; pratense, mosaic of, 146–147
Triticum dicoccum, 212, durum, 206, 211, 212; vulgare, 206, 211, 212; reaction of F_2 generation (durum x vulgare) to Puccinia graminis, 205–213
TROST, JOHN F. and HOFFER, G. N. Kernel starchiness as an index of susceptibility to root, stalk and ear rots of corn, 33–34
Tsuga canadensis, Hymenochaete tabacina on wood of, 320; canadensis, Polyporus nidulans on wood of, 323 canadensis, Trametes heteromorpha on wood of, 326; heterophylla, host of Polyporus dryadeus, 99; heterophylla host of Thelephora caryophyllea, 144; heterophylla, Fomes applanatus on wood of, 324; heterophylla, Polystictus versicolor on wood of, 321; mertensiana, host of Polyporus dryadeus, 99
Tylenchulus semipenetrans on citrus roots 90–93
Tylenchus tritici, 41

Umbellularia californica, host of Fomes applanatus, 326

Uredo coleosporioides, 45
Uromyces, alchemillae, 388; betae, 388
Ustilgo tritici, incidence in wheat varieties, 507–510; zeae, 32

VALLEAU, W. D., Resistance as a basis for control of corn root rot, 34; Selection of disease-free seed and seed treatments as possible means of contro. of corn root rot, 35
Valsa, sp., causing poplar canker, 45; leucostoma, 236–243, 293; lupini, on Lupinus arboreus, 391; sordida, 163
VAUGHAN, R. E., Inoculated sulphur for potato scab control, 58; see JONES, FRED REUEL
Velvet bean, host of Sclerotium rolfsii, 378
Venturia inaequalis on apple, 43–44
Vicia faba, host of clover mosaic, 147; mosaic of, 202
Violet root rot, 412-423
Viscum, mucilage of, 99

WALKER, J. C., A Macrosporium rot of onion, 53; The occurrence of dodder on onions, 53; Rust of onion followed by a secondary parasite, 87–90; and JONES, L. R., The relation of soil temperature and other factors to onion smut and infection, 52–53
Walnut, see Juglans nigra
Wart of potato, heredity of immunity to, 306–310; character of growth, 57; resistant varieties, 57; status in Pennsylvania, 58
WEBER, G. F. Studies on corn rust, 31-32
WEIMER, J. L., see HARTER, L. L.
WEISS, FREEMAN, and ORTON, C. R., Second report on the reaction of American potato varieties to the wart disease, 57; and HARVEY, R. B. Catalase, hydrogen-ion concentration and growth in the potato wart disease, 57; see ORTON, C. R.
Western, white pine, see Pinus monticola; yellow pine, see Pinus ponderosa
WESTON, W. H. JR., Significant points in the life history of the Philippine maize mildew, 32; A note relative to the recent appearance of the sugar cane downy mildew in the Philippines, 371–375
Weymouth pine, see Pinus strobus
WEIR, JAMES R., The mucilage of mistletoe berries as an adhesive, 99; Polyporus dryadeus (Pers.) Fr. on conifers in the Northwest, 99; Thelephora terrestris, T. fimbriata, and T. caryophyllea on forest tree seedlings, 141–144; Note on Cenangium abietis (Pers.) Rehm on Pinus ponderosa Laws., 166–170; Polyporus schweinitzii Fr. on Thuja plicata, 176; Cenangium **piniphilum** n. sp., an undescribed canker forming fungus on Pinus ponderosa and P. contorta, 294–296
WELLES, COLIN G., see LEE, H. ATHERTON
Wheat, black point of, 515; bunt of, 37–39; foot rot of, 37; host of Wojnowicia graminis, 505–506; injury by seed treatment of, 103; loose smut of, 507–510; orange leaf rust of, 40; reaction to Puccinia graminis, 205–213; scab of, 35, 115–124; seedling blight of, 35–37; stem rust of, 202; stinking smut of, 269-278; take-all of, 37
WHETZEL, H. H., The Phytopathological Society of France, 100–101; and H. B. HUMPHREY, Frederick Kolpin Ravn, biographical sketch and portrait, 1–5
White pine, see Pinus strobus
Wild cucumber, eradication of, 47
Wildfire of tobacco, relation of air temperature to, 446–458
WILLIAMSON, MAUDE MILLER, see JONES, L. R.; see TISDALE, W. B.
Wilting caused by walnut trees, 346
WINELAND, GRACE, see DICKSON, JAMES G.
WINGARD, S. A., see FROMME, F. D.
Witches'-brooms, of Pinus maritima, 27
WOLF, FREDERICK A., and SHUNK, I. V Tolerance to acids of certain bacterial plant pathogens, 244–250; see SHUNK, I. V.
Wood-rotting fungi, field cultures of, 151–

154; new or little-known hosts for, 319–326
Wojnowicia graminis on wheat, 505–506

Yellows, of cabbage, 54; of celery, 54–55
YORK, H. H., see PENNINGTON, L. H.
YOUNG, H. C. and BENNETT, C. W., Studies in parasitism in the Fusarium group. 56

ZELLER, S. M., Heart-rot of prune and peach in Oregon, 105; A spur blight of pear caused by Botrytis, 105; ZELLER S. M., and OWENS, C. E. European canker on the Pacific Slope, 464–468
Zea, amylacea, 32; dentata, 32; everta, 32; indurata, 32; ramosa, 32; saccharata 32; tunicala, 32; mays indentata, host of Sphacelotheca reiliana, 515; mays saccharata, host of Sphacelotheca reiliana, 515
Zinc-Bordeaux, 185
ZUNDEL, GEORGE L., Preliminary experiments on injury to wheat from seed treatment in Washington, 103; The effects of treatment for bunt on the germination of wheat, 469-484

American Phytopathological Society

President, DONALD REDDICK, Cornell University, Ithaca, N. Y.
Vice-President, G. H. COONS, Michigan Agricultural College, East Lansing, Mich.
Secretary-Treasurer, G. R. LYMAN, U. S. Department of Agriculture, Washington, D. C.

ADDITIONAL MEMBERS OF THE COUNCIL

G. H. COONS, Michigan Agricultural College, East Lansing, Mich.
N. J. GIDDINGS, West Virginia University, Morgantown, W. Va.
W. A. ORTON (ex officio), U. S. Department of Agriculture, Washington, D. C.
PERLEY SPAULDING (ex officio), U. S. Department of Agriculture, Washington, D. C.
J. H. FAULL, University of Toronto, Canada, representing the Canadian Division.
H. S. REED, Citrus Exp. Sta., Riverside, Calif., representing the Pacific Coast Division.
H. R. ROSEN, University of Arkansas, Fayetteville, Ark., representing the Southern Division.

Phytopathology

OFFICIAL ORGAN OF THE SOCIETY

EDITORS

PERLEY SPAULDING, Editor-in-Chief, U. S. Department of Agriculture, Washington, D. C.
H. S. JACKSON, Purdue University, LaFayette, Ind.
GEO. M. REED, Brooklyn Botanic Garden, Brooklyn, N. Y.

ASSOCIATE EDITORS

F. D. HEALD, State College of Washington, Pullman, Wash., 1919–21.
J. E. HOWITT, Ontario Agricultural College, Guelph, Canada, 1919–21.
J. B. S. NORTON, University of Maryland, College Park, Md., 1919–21.
GEO. L. PELTIER, Agricultural Experiment Station, Linoeln, Neb., 1919-21.
G. H. COONS, Michigan Agricultural College, East Lansing, Mich., 1920–22.
N. J. GIDDINGS, West Virginia University, Morgantown, W. Va., 1920–22.
NEIL E. STEVENS, U. S. Department of Agriculture, Washington, D. C., 1920–22.
J. A. STEVENSON, U. S. Department of Agriculture, Washington, D. C., 1920–22.
G. R. BISBY, University of Manitoba, Winnipeg, Canada, 1921–23.
J. FRANKLIN COLLINS, Brown University, Providence, R. I., 1921–23.
L. R. HESLER, University of Tennessee, Knoxville, Tenn., 1921–23.
A. G. JOHNSON, University of Wisconsin, Madison, Wis., 1921–23.

BUSINESS MANAGEMENT

G. R. LYMAN, Business Mgr., U. S. Dept. of Agriculture, Washington, D. C.
ROY G. PIERCE, Advertising Mgr., U. S. Dept. of Agriculture, Washington, D. C.

NOTICES

Manuscript may be sent to the nearest member of the editorial board. Clearness, brevity and conciseness are essential. In form and style manuscript should conform to the best usage in this journal. It should be typewritten on one side of the paper and sent unfolded.

Illustrations necessarily must be limited in number, and photographs, to reproduce satisfactorily, must be of the best quality. Line drawings reproduce best as text figures. Authors desiring unusual numbers of illustrations or special types of reproduction will be asked to bear part of the expense.

Subscription price. $5.00 per year United States and dependencies, Mexico and Cuba; Canada $5.25; other countries $5.50; current single numbers 50 cents. The journal is issued monthly beginning with Vol. VIII, January, 1918.

Requests to supply lost copies of the journal must be made within 60 days from date of issue. Date of issue January 1 and monthly thereafter.

Separates. No gratis copies are supplied. A printed schedule of prices is submitted with the proof and authors may secure separates by placing an order when proof is returned.

Back Volumes may be obtained unbound at $6.00 per volume, postage paid.

Separate copies will not be sold except in cases where the volumes are already broken. The price of such copies is $1.00 each for volumes I to VII nclusive, and 50 cents each for subsequent years. Prices net postpaid.

THE AMERICAN ENTOMOLOGICAL SOCIETY

PHILADELPHIA

Founded 1859 Incorporated 1862

Organized as "The Entomological Society of Philadelphia," the present title was adopted February 11, 1867.

PRESIDENT
Henry Skinner

VICE-PRESIDENT
James A. G. Rehn

CORRESPONDING SECRETARY
Morgan Hebard

RECORDING SECRETARY
R. C. WILLIAMS, JR.

TREASURER
Ezra T. Cresson

PUBLICATION COMMITTEE	FINANCE COMMITTEE	PROPERTY COMMITTEE
James A. G. Rehn, *Editor*	Morgan Hebard, *Chairman*	Ezra T. Cresson, Jr., *Librarian* and *Custodian*
Ezra T. Cresson	D. M. Castle	Morgan Hebard
Philip P. Calvert	James A. G. Rehn	Philip Laurent

Meetings held (alternately with those of the Entomological Section of The Academy of Natural Sciences of Philadelphia) on the fourth Thursday of September, October, November, January, February, March, April and May, and on the second Monday of June and December (annual meeting). The offices, meeting room, library and collections of the Society are in the Entomological Department of The Academy of Natural Sciences of Philadelphia, Logan Square.

SERIAL PUBLICATIONS OF THE SOCIETY

Proceedings of the Entomological Society of Philadelphia, volumes I–VI, 1861–1867. Out of print and cannot be supplied.

Transactions of the American Entomological Society, volumes I–IV, out of print and cannot be supplied; V–X, $5.00 per volume; XI–XLVI, $4.00 per volume. Published in annual volumes of quarterly parts.

The Practical Entomologist, volumes I–II, 1865–1867. Price, $1.00 for the two volumes.

Memoirs of the American Entomological Society, number 1, 1916, price $2.00; number 2, 1917, price $4.50; number 3, 1919, price $1.50; number 4, 1920, price $2.50. Published irregularly.

Entomological News, volumes I–XXXI. Price $2.00 per volume. Published in conjunction with the Entomological Section of The Academy of Natural Sciences of Philadelphia.

Various irregular, non-serial publications have been issued, which may be found in our price lists under their respective authors.

To establish the date of issue, each paper, as soon as completed, is placed on sale and a copy of it is mailed to each of the following institutions, with a request that it be placed in their library for reference.

Boston Society of Natural History	Field Museum of Natural History
American Museum of Natural History	California Academy of Sciences
Smithsonian Institution	Entomological Society of Ontario

Separates of papers published in the Proceedings and Transactions, if not out of print, can be supplied at prices given in our price lists, which are sent upon application, stating order or orders desired. The Society has also inauguarated a system of subscription to papers published by it on individual orders, which arrangement is of material benefit to the student who desires promptly the literature on any special group, but who does not desire to subscribe to entire volumes of the Transactions. A method of notification of the appearance in its publications of papers relating to individual orders or subjects has been developed by the Society. Information concerning these arrangements supplied upon application.

In sending subscriptions or in making inquiries relative to publications, address:

THE AMERICAN ENTOMOLOGICAL SOCIETY,
PUBLICATION DEPARTMENT,
The Academy of Natural Sciences of Philadelphia
Logan Square.

SINCE the discovery of the science of spraying no experimental or half-tested spray material has ever been on the market under a Grasselli label.

Grasselli Grade Insecticides and Fungicides are absolutely unvarying in strength and quality—they MUST be so in order to earn the Grasselli label to align with the world-wide Grasselli name and 82 years of chemical leadership.

ARSENATE OF LEAD

CALCIUM ARSENATE

LIME SULPHUR SOLUTION

THE GRASSELLI CHEMICAL CO.

CLEVELAND

Dusting

Orchard, Vegetables, Vineyards, Shade Trees, Plants, is much easier, faster, cheaper, than spraying. Niagara Dusters envelope trees and plants in Niagara Dusts, invisible and impalpable: atoms are too small to see or feel, but the bug finds the atom just his size, and fungus shrivels by contact and is no more.

The U. S. Department of Agriculture has recommended dusting, and many State Experiment Stations have tested dusting and pronounced it more Effective than spraying and far less Laborious and Costly.

Write the

NIAGARA SPRAYER COMPANY

MIDDLEPORT, N. Y.

Intelligencer Printing Co.

8 WEST KING STREET

LANCASTER, PA.

Printers, Binders, Engravers

of

BOOKS, CATALOGUES

PUBLICATIONS

MONOTYPE TYPE-SETTING MACHINES

MIEHLE PRINTING PRESSES

Estimates Invited